The Absence of Cradling Bias in Autism Spectrum Disorders: Illustrating Deficits in Basic Empathic Processes

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COMPULSORY DECLARATION

This work has not been previously submitted in the whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or the works, of other people has been attributed, and has been cited and referenced.

Signature:____ Date:_____________________

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Table of Contents

List of Figures

List of Tables

Abstract

Deficits in *empathy* are considered a defining characteristic of autism spectrum disorders (ASDs). A fundamental difficulty these individuals experience is that of relating to others. Impairments in both top-down and bottom-up processes involved in relating are implicated, as these individuals experience difficulties in relating to others on both a cognitive and a visceral level. Research focussing on their more basic difficulties with social reciprocity (i.e., bottom-up processes of relating) is, however, lacking.

A well-established social phenomenon, namely cradling bias (i.e., the preference to cradle an infant to the left of the body midline) is argued to be facilitated by a capacity for empathy. Previous studies provide reason to suspect that this phenomenon taps into the innate ability to relate to another; in other words, it taps into basic bottom-up empathic processes. With the goal of drawing attention to the very basic difficulties in relating and social reciprocity pervading ASDs, I investigated whether the universal leftward cradling bias was absent in ASD children.

This research consisted of a pilot and a main study. Both studies were cross-sectional comparisons of two groups: an ASD group and a Control group. For both studies, the method employed was quasi-experimental, as participants were divided into groups based on the pre-existing criterion of diagnosis (i.e., ASD and Control). The ASD groups (for both studies) included children diagnosed with low-functioning autism, high-functioning autism, Asperger's syndrome, and pervasive developmental disorder-not otherwise specified. For the pilot, the Control group consisted of only typically developing children, whereas for the main study, the Control group consisted of typically developing as well as mentally handicapped children.

Direct systematic observation was employed to compare the occurrence of cradling bias across groups. In the pilot study, 20 ASD children, aged 6-14, and 20 Control children, aged 5-15, were asked to cradle a doll as if it were an infant she/he were trying to put to sleep or soothe on three separate occasions. These participants were perfectly matched on age and gender. In the main study, 53 ASD children, aged 6-16, and 40 Control children, aged 6-15, were asked to cradle a doll on four separate occasions. These participants were matched as closely as possible on age and gender.

Regression analyses on both the pilot and the main study data revealed that the universal leftward bias was absent in ASD children. In contrast, a clear leftward bias was present in Control children, both typically developing and mentally handicapped. These

group differences were not accounted for by differences in gender, handedness, intellectual and/or executive functioning. Moreover, differences in the quality of the child-doll (i.e., caregiver-infant) interaction in the cradling bias scenario illustrated the very basic social-emotional difficulties experienced by ASD individuals.

The cradling bias scenario is one instance where impairments in primitive bottom-up processes of relating in ASDs can be illustrated. Further investigation of these bottom-up difficulties will allow for a more nuanced understanding of the empathy deficits (i.e., social-emotional deficits) by which ASDs are characterised, which in turn has implications for the management and treatment of these individuals.

Introduction

Humans are an "exquisitely social species" (Gallese, Keysers, & Rizzolatti, 2004, p. 396) for whom interaction with others, whether it be in groups or in close relationships, is adaptively advantageous (Brüne & Brüne-Cohrs, 2006; Decety, 2011; Gallese, 2001). Effective social functioning is fundamental to our survival as a species (Cacioppo, 2002; Singer et al., 2004). For example, a speedy and accurate evaluation of, and response to, others' motives can lead to securing benefits such as protection and food-sharing (Brothers, 1989; Brüne & Brüne-Cohrs, 2006). In particular, the ability to *empathize* with others is recognized as a significant facilitator of social behaviour, as it results in the formation of relationships between individuals (Decety, 2011; Johnson, Cheek, & Smither, 1983; Preston & de Waal, 2002). The adaptive value of the ability to empathize with others is unquestionable.

What exactly *empathy* refers to is the subject of ongoing debate. The literature acknowledges the complexity of this construct, and reference is made to numerous components or aspects thereof. Until recently, empathy has been conceptualized as a unitary construct consisting of various independent components. However, a recent shift toward a view of empathy as a *behaviour* has emerged, where empathic behaviour is viewed as a consequence of numerous interacting (empathic) processes (e.g., see Decety, 2011). Empathic processes are involved in relating[1]; essentially, empathy is concerned with how individuals relate to one another. Empathic processes include both top-down processes (i.e., those involved in understanding what someone else is feeling on a cognitive level) as well as bottom-up processes (i.e., those involved in viscerally feeling what someone else is feeling). Empathic behaviour depends on how top-down and bottom-up processes of relating are regulated.

Deficits in *empathy* are considered by some as a defining characteristic of autism spectrum disorders (ASDs) (e.g., Baron-Cohen, 1989; Baron-Cohen et al., 1985; de Bildt et al., 2005; Gillberg, 1992; Hermans, van Wingen, Bos, Putman, & van Honk, 2009). Kanner (1943) originally described autistic individuals as having "come into the world with an innate inability to form the usually biologically provided affective contact with other people" (p. 250). A basic difficulty these individuals experience is that of relating to others (Kanner, 1943; Wing & Gould, 1979). In terms of ASD research, much attention has been directed at top-down processes when accounting for these individual's difficulties in relating, whereas

[1] Note that *empathic processes* and *processes of relating* are used as interchangeable terms throughout this dissertation.

bottom-up processes have been relatively neglected. As a result, deficits in top-down empathic processes in ASD are relatively clear, whereas the bottom-up deficits are less clearly understood.

The well-established social phenomenon known as *cradling bias* (i.e., the human preference to cradle an infant to the left of the body midline) provides us with one way in which to investigate bottom-up processes involved in relating. Numerous studies support the contention that cradling bias is facilitated by a capacity for empathy (e.g., Bourne & Todd, 2004; Harris, 2010; Sieratzki & Woll, 2002; Suter, Huggenberger, & Schächinger, 2007). Specifically, the universal leftward cradling bias is argued to be associated with enhanced quality of the caregiver-infant interaction and subsequent relationship; it taps into basic, bottom-up processes of relating (Bogren, 1984; de Chateau, Holmberg, & Winberg, 1978, Turnbull & Collins, 2000).

The current study aimed to gain a clearer, more nuanced understanding of the nature of the empathy deficits by which disorders on the autism spectrum are characterised. Investigating the occurrence of cradling bias is one way in which to investigate the very basic social-emotional difficulties that seem to be experienced by individuals with ASDs. Having a better understanding of these more basic processes may have implications for intervention; if we can illustrate what breaks down, where it breaks down, and how it breaks down, we can perhaps develop interventions that can assist with or target these specific areas. It is possible that this could serve as the foundation upon which higher-order social skills training - which is already in place and being implemented - may be more effective.

Review of the Literature

Defining Empathy

The term *empathy* was originally defined by Titchener (1917) as “the name given to that process of humanizing…of reading or feeling ourselves into” (p. 417). What exactly this term encompasses is the subject of ongoing debate (e.g., Batson, 2009; Baron-Cohen, 2008; Blair, 2005; Decety, 2011; Gerdes, Segal, & Lietz, 2010; Preston & de Waal, 2002; Rueckert & Naybar, 2008). The literature acknowledges the complexity of this construct, and reference is made to numerous components or aspects thereof, such as emotional contagion, motor mimicry, sympathy, cognitive empathy, affective or emotional empathy, perspective-taking, and helping behaviour, to mention a few (Blair, 2005; Decety & Lamm, 2006; Minio-Palluelo, Baron-Cohen, Avenanti, Walsh, & Aglioti, 2009; Preston & de Waal, 2002).

A common distinction frequently made in the literature is the distinction between cognitive and affective (or emotional) empathy (Blair, 2005; Decety & Jackson, 2004; Preston & de Waal, 2002). Cognitive empathy (similar to the concept of Theory of Mind; ToM) refers to the ability to recognize mental states in others, and understand that others can “know, want, feel, or believe things” (Baron-Cohen, Leslie, & Frith, 1985, p. 38; Premack & Woodruff, 1978). Affective empathy, on the other hand, involves the feeling of a similar emotion (Rueckert & Naybar, 2008). Essentially, it can be argued that cognitive empathy refers to *knowing* what someone else is feeling (i.e., understanding on a cognitive level), whereas affective empathy refers to *feeling* what someone else is feeling (i.e., understanding on a visceral level; Soto & Levenson, 2009).

A third component of empathy, namely motor empathy, is described by Blair (2005) as a tendency to imitate the motor responses of others, such as facial expressions and postures. Some, such as Minio-Palluelo and colleagues (2009), argue that the automatic imitation of others’ external expressions of their mental state triggers a similar mental state in the individual. Preston and de Waal (2002) incorporate the notion of motor empathy into their Perception-Action Model (PAM) of empathy. The PAM proposes that perceiving a behaviour and/or state in another automatically triggers one’s representations of this behaviour/state, which then triggers autonomic and somatic responses unless they are inhibited by the individual. Such state-matching reactions are related in the Theory of Mind literature to simulation theory and the mirror neuron theory (Gallese, 2001; Gallese et al., 2004; Rizzolatti, Fadiga, Gallese, & Fogassi, 1996).

A framework for empathy: empathic behaviour. There is no doubt that empathy is a complex construct. Recently, conceptualization of empathy has begun to shift away from the view of empathy as a unitary construct consisting of various independent components or aspects (Batson, 2009; Decety, 2011). Instead, Decety and colleagues (2011; Decety & Jackson, 2004; Decety & Meyer, 2008; Decety & Moriguchi, 2007), for example, posit that empathy should be conceptualized in terms of *empathic behaviour*, which is facilitated by numerous brain processes. According to this framework, *empathic behaviour* is a consequence of the interaction between three components, namely (1) bottom-up processes, (2) top-down processes, and (3) regulatory processes. In this view, empathic behaviour is a consequence of the interaction between bottom-up and top-down brain processes involved in relating, and the likelihood of engaging in a particular empathic behaviour depends on how these components are regulated.

This framework is best explained by an example. To illustrate, suppose you are in the queue at a grocery store and the toddler behind you, accompanied by his mother, throws a deafening tantrum: His mother has just told him he cannot have the chocolate bar that he wants. Think about what your reaction might be. How empathic will you be? *Will* you behave empathically?

Imagine you woke up this morning to discover that the milk had gone off and, as a result, you did not have your morning coffee. It is close to noon and you have only now been able to get to the store to buy milk. While waiting in the queue you are aware of your irritability and a headache which has recently begun to develop. The yelling behind you is not helping. After a while, the child has not quietened down, so you turn around and tell the mother that her child is a brat and is in need of a decent scolding. Alternatively, you might take the perspective of the mother, who is likely to be embarrassed by her child's behaviour. You might empathize with what this mother is feeling, which might down-regulate your negative feelings towards the toddler. As a result, you might offer that the mother be served before you.

The complexity of empathic behaviour is evident. These are merely two of several possible outcomes. What would your reaction be if you were not in such a foul mood or did not have a headache? What would your reaction be if you yourself were a parent, and had been in a similar situation before? What would your reaction be if you were friends with the mother, or the toddler's teacher? This example demonstrates how various factors such as interpersonal and situational factors can influence, and essentially motivate, empathic (or non-empathic) behaviour. Moreover, it draws attention to the idea that empathic behaviour is not necessarily a reflection of the ability to empathise, but rather a reflection of how top-down and bottom-up processes involved in empathic behaviour are regulated. Regulatory processes involved in relating could prevent you from giving the toddler a scolding right there in the queue. As Decety and colleagues argue, higher-order processes (top-down processes) are involved in modulating and regulating visceral, subjective empathic processes (bottom-up processes).

Thus, our ability to relate to others does not necessarily lead to engaging in empathic behaviour (Decety, 2011). Dadds and colleagues (2008) explain that, “Empathy, and the lack of it, is an important construct in explanations of the most appealing and appalling aspects of human behaviour” (p. 111). Empathic behaviour is something that needs to be regulated; it involves a regulatory component (Decety, 2011; Decety & Lamm, 2006). Even if we understand others’ emotions, our intentions and motivations can, and will likely, influence whether or not we engage in empathic behaviour. This is an important point to be taken into account in research investigating empathic behaviour.

Empathic behaviour: processes of relating. In developing their framework, Decety and Lamm (2006) point out that what is common to the numerous definitions of empathy seen in the literature is the notion that empathy is concerned with emotion-sharing, with “the ability to experience and understand what others feel” (p. 1146). Importantly, this emotion-sharing must occur “without confusion between oneself and others” (p. 1146). Empathic behaviour therefore relies on a blurring of the line between self and other (i.e., sharing another’s emotion; Klein & Hodges, 2001), while still being able to see that line (i.e., being able to differentiate between the self and other). Gallese and colleagues (2004) speak of how we bridge the gap between first and third person, while preserving our own identity.

In line with this thinking, I work from the perspective that empathic behaviour is fundamentally concerned with brain processes, both top-down and bottom-up, which enable us to *relate* to others. In other words, empathic behaviour is facilitated by the ability to relate to others, to understand or share others’ feelings, whether it be on a cognitive or a visceral level[2].

Relating and attachment. Decety and Lamm’s (2006) argument highlights how the ability to relate to others depends on the ability to differentiate between the self and the other. Self-other differentiation enables us to relate to others, shaping our ability to interact as social

[2] Top-down processes represent relating on a cognitive level, whereas bottom-up processes represent relating on a visceral level, similar to the concepts of Cognitive empathy and Affective empathy, respectively.

beings. It facilitates the formation and maintenance of relationships between individuals as well as between groups, which holds obvious advantages for our survival. Some argue that what Decety and Lamm are referring to is the innate psychobiological capacity that human beings are born with; the capacity to engage with and respond to social stimuli (Shaver & Mikulincer, 2005). Theorists such as Bowlby (1969) would refer to this as the innate tendency to attach to another person.

As Bowlby explains, the human infant is 'made' in such a way that it readily interacts with and invariably forms emotional attachments to others to ensure survival. Human infants are born immature and are slow to develop; they come into the world unprepared for the task of survival (Pyszczynski, Greenberg, Solomon, Arndt, & Schimel, 2004). They are not sufficiently developed to survive on their own and are therefore highly dependent on the caregiver. The mother-infant (or caregiver-infant) dyadic interaction is therefore viewed as essential for human survival, and is placed alongside mating behaviour in terms of significance for survival of the species (Bowlby, 1969). This interaction plays a role in the maintenance of physical as well as psychological wellbeing.

Bowlby believed that attachment behaviour serves a protective function. He argued that the first relationship an infant forms with his/her caregiver (usually the mother) serves as a template for future relationships, referred to as a *working model*. The infant spends most of his/her time with the primary caregiver and builds a working model as he/she learns about what to expect from others, and essentially learns a style of relating. This facilitates functioning within a social environment (Shaver & Mikulincer, 2005). The argument is made that 'good' attachment is conducive to empathy development, as it reflects healthy ways of relating to others.

Attachment behaviour, defined by Bowlby as seeking and maintaining proximity to another individual of the same species, is considered evidence of this innate psychobiological capacity to relate to another individual. I argue that attachment behaviour comes about as a result of bottom-up processes of relating, as it reflects primitive mechanisms in place which, in a sense, prompt the individual to interact with another, and thereby facilitates relating. Such mechanisms would be related in the literature to the evolutionarily conserved social-motivational system proposed by Panksepp and colleagues (Panksepp, 1998; Watt & Panksepp, 2009; Zellner, Watt, Solms, & Panksepp, in press).

Gender differences in empathy and empathic behaviour. An argument is often made that empathic behaviour is influenced by *gender*. For example, gender stereotypes would have us believe that women are more emotional than men, and/or have a greater ability to empathize with others (Klein & Hodges, 2001; Lennon & Eisenberg, 1987). Furthermore, societal roles and cultural norms call for particular behaviours from men and women (e.g., Greif, Alvarez, & Ulman, 1981; Dunn, Bretherton, & Munn, 1987). In the past, the woman was often the primary caregiver, whereas the man was more likely to be the primary provider. Evolutionary arguments (e.g., Greary & Flinn, 2002; Knickmeyer, Baron-Cohen, Raggatt, & Taylor, 2005) suggest that women should be superior to men on sociocognitive abilities. The evidence for gender/sex differences in empathic behaviour will be considered below.

A number of studies provide evidence for the existence of certain gender differences in empathy. For example, a female advantage has been found in reading non-verbal communication signals such as facial expressions and body language (Baron-Cohen, Wheelwright, & Hill, 2001; Hall, 1978). However, although females tend to be better at reading overall emotions, in specific, males were found to be better at reading anger in other males (Rotter & Rotter, 1998). Furthermore, Dadds and colleagues (2008) illustrate that males tend to score higher on measures of cognitive empathy, whereas females tend to score higher on items measuring affective empathy. In other words, some research indicates that males tend to be better at *knowing* what another person is feeling (i.e., understanding on a cognitive level), whereas females tend to be better at *feeling* what another person is experiencing (i.e., understanding on a visceral level). In contrast to this, several studies support the notion that females are, on average, superior at inferring mental states in others, a measure of cognitive empathy (Banerjee, 1997; Baron-Cohen, Jolliffe, Mortimore, & Robertson, 1997; Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999; Happé, 1995).

By and large, studies have argued that females generally score higher on empathic measures than males do (Gault & Sabini, 2000; Macaskill, Maltby, & Day, 2002; Schieman & van Gundy, 2000). Although findings suggest that females are generally more empathic than males, results have varied considerably across studies. Despite the evidence for certain gender differences, clearly describing these differences has proven challenging.

An argument can be made that perhaps the difficulty in describing these differences across genders, as well as the inconsistencies in findings across studies, are linked to the way in which empathy is conceptualized. Instead of conceptualizing empathy as a unitary construct consisting of various independent components, it would be more useful (or accurate) to view empathy as a behaviour, with many interdependent components contributing to empathic behaviour. As Decety and colleagues suggest, various factors contribute to whether or not we engage in empathic behaviour. It is plausible to argue that gender can be a motivating factor in empathic behaviour, and therefore may account for the differences in empathic behaviour seen across genders.

In line with this, Rueckert and Naybar (2008) argue that it is possible that "men and women may not differ in overall empathic capacity so much as the types of situations under which empathy is elicited" (p. 165). Klein and Hodges (2001) investigated differences in empathic accuracy (i.e., accurately inferring an emotion in another person), and provide compelling evidence that motivation to be empathic can significantly influence empathic accuracy. They found a significant difference in empathic accuracy (i.e., women more accurate than men) before a monetary incentive was provided. However, once monetary incentive was provided to accurately infer an emotion (i.e., participants would be paid if they correctly inferred emotions), this difference disappeared. In fact, men out-performed women, although not significantly. As a result of this study, Klein and Hodges argue that motivation to be empathic can influence one's ability to 'read' another's emotions, and must therefore be taken into consideration when investigating gender differences in empathy. It is possible that men and women do not differ in empathic ability, but rather in their motivation to behave empathically, which in turn results in differences in empathic behaviour. Klein and Hodges suggest that this tendency is likely linked to "priming aspects of the traditional gender role"(p. 721), in that women tend to view being empathic as an important part of their self-concept.

It is clear that differences in empathic behaviour can be influenced by gender. The literature suggests that the difference in empathic behaviour across genders does not necessarily reflect differences in the ability to empathize, but rather that various factors motivate whether or not an individual engages in empathic behaviour. Klein and Hodges clearly demonstrate how motivation to be empathic facilitates the expression of this behaviour. It is of note, however, that in the absence of a monetary incentive, women out-performed men when reading others' emotions. This finding cannot make any claim about the differences in empathic ability between genders (i.e., that one gender is 'better'). It does, however, suggest that it is possible that females are more naturally motivated than males to behave empathically when it comes to inferring what others are feeling. Whether or not this is linked to gender roles or differences in physiology requires further investigation.

A physiological basis for differences in empathic behaviour. While it is clear that *gender* can be a motivating factor in our decision to engage in empathic behaviour, there is ample evidence linking physiological differences in the brain across the sexes to differences in empathic behaviour. Baron-Cohen proposes the notion of a male and female brain; and specifically, that the female brain type is naturally better at empathizing. This argument is based on compelling evidence for physiological sex differences which may be responsible for differences in empathic behaviour. For example, a recent avenue of investigation indicates that differences in empathic behaviour are linked to foetal testosterone levels (Ingudomnukul, Baron-Cohen, Wheelwright, & Knickmeyer, 2007; Knickmeyer, Baron-Cohen, Raggatt, Taylor, & Hackett, 2006). The level of foetal testosterone in the amniotic fluid furthermore also plays a critical role in the development of the brain, and is reflected in the difference in brain structures found across the sexes (Arnold, 1996; de Vries et al., 2002; Fitch & Denneberg, 1998). These points will be elaborated on shortly (i.e., when discussing the implications physiological differences may have with regard to autism spectrum disorders).

Autism Spectrum Disorders and Empathy

Autism spectrum disorder. Autism spectrum disorder (ASD) is an umbrella term which includes autistic disorder (or *autism*), Asperger's syndrome, and pervasive developmental disorder-not otherwise specified (PDD-NOS; American Psychiatric Association [APA], 2000).[3] According to the text revision of the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; APA, 2000), these conditions are characterised by three core deficits, namely (1) deficits in social interactions, (2) impaired verbal and non-verbal communication, and (3) repetitive, restricted or stereotyped behaviour, interests and activities.

Autistic disorder is defined as a developmental disorder whose onset must be prior to 3 years of age and which is characterised by these three core deficits (APA, 2000). Autistic individuals can further be divided according to IQ into low-functioning autism (LFA, IQ < 75) and high-functioning autism (HFA; IQ ≥ 75). Individuals with Asperger's syndrome are similar to HFA individuals, as they exhibit the same impairments in social interaction and communicative behaviour, as well as repetitive and restrictive behaviour. However, an individual with Asperger's will display normal development of language skills and have an average or above-average IQ (Hill & Frith, 2003; Macintosh & Dissanayake, 2004; see Appendix A for the full diagnostic criteria of autistic disorder and Asperger's syndrome). If an individual does not meet the criteria for a specific ASD, but shows severe impairments in

[3] Autistic disorder, Asperger's syndrome, and PDD-NOS fall under the broad category of ASD. The DSM-IV-TR lists these conditions under the Pervasive Developmental Disorders diagnostic category, along with two additional conditions, namely Rett's disorder and childhood disintegrative disorder. Rett's disorder and childhood disintegrative disorder are, however, relatively rare. This research does not include children diagnosed with these two conditions.

the three core deficits characterising these conditions, a diagnosis of pervasive developmental disorder-not otherwise specified (PDD-NOS) is made.

Within the spectrum, diagnosis varies according to intellectual ability, communication ability and presenting behavioural symptoms (Pellicano, 2007). All diagnoses are, however, characterised by ineffective social skills as well as deficits in empathy (i.e., social-emotional difficulties; de Bildt et al., 2005; Hermans et al., 2009; Minio-Paluello et al., 2009). Although much controversy surrounds the validity of the subcategories of ASD (as is evidenced by the changes currently being made for the next edition of the DSM to be published in 2012), impaired social skills and *deficits in empathy* remain key elements required for an ASD diagnosis (for examples, see South, Ozonoff, & MacMahon, 2005, and Tidmarsh & Volkmar, 2003).

Empathy in ASDs. Some consider deficits in empathy as a defining characteristic of autism spectrum disorders (ASDs) (e.g., Baron-Cohen, 1989; Baron-Cohen et al., 1985; de Bildt et al., 2005; Gillberg, 1992; Hermans, van Wingen, Bos, Putman, & van Honk, 2009). A fundamental difficulty these individuals experience is that of relating to others (Kanner, 1943; Wing & Gould, 1979). Impairments in both top-down and bottom-up processes involved in relating are implicated, as these individuals experience impairments in processes which allow us to relate to others on both a cognitive and a visceral level.

It is important to note the distinction between top-down processes that are uniquely involved in relating (i.e., empathic behaviour), and those top-down processes that are domain general. Theory of Mind skills, for example, are uniquely involved in relating, whereas top-down processes such as executive functions, particularly those involved in regulating behaviour, are not limited to influencing empathic behaviour.

Top-down processes. Intact top-down functioning is beneficial for both social and emotional interactions. Top-down processes play an important role in regulating empathic behaviour; in specific, these processes regulate and modulate bottom-up processes of relating.

Often top-down processes, many of which facilitate relating to others on a cognitive level, are impaired in ASD individuals. Much attention has been directed at these processes when accounting for the difficulties ASD individuals experience. This is evidenced by several cognitive theories which have dominated autism research until recently (see Rajendran & Mitchell, 2007 for a comprehensive review). These include, but are not limited to, the Theory of Mind theory of autism, the dysexecutive function theory of autism, and the notion that ASD individuals experience specific difficulties with attention.

The Theory of Mind (ToM) theory of autism. The ToM theory of autism has received much attention for some time (Baron-Cohen et al., 1985; Pellicano, 2007). Research has focussed on the role of ToM in social behaviour (Baron-Cohen et al., 1985; Frith & Frith, 2006). The ability to infer emotions (i.e., what others feel) has often been included in the definition of ToM (e.g., Brüne & Brüne-Cohrs, 2006). Some, however, such as Saxe and colleagues (2003; 2004), argue that ToM concerns only epistemic mental state inference, and not affective mental state inference. ToM skills reflect one of many top-down processes involved in relating, and can therefore influence whether or not one engages in *empathic behaviour.*

Important to note is that ToM is a higher-order ability. Early precursors of ToM such as joint attention, language acquisition, and engaging in pretend play, typically emerge between 14 and 24 months of age (Charman et al., 2000; Frith & Frith, 2003). However, children only begin to understand others' false beliefs (i.e., being able to distinguish between one's thoughts and the real world) - marking the emergence of ToM - between the ages of 3 and 5 years (Bibby & MacDonald, 2005; Naito, Komatsu, & Fuke, 1994). This draws attention to the higher-order nature of this skill; ToM skills reflect top-down processes.

Other top-down explanations. Several other explanations drawing on domain-general top-down processes have received considerable attention. For example, the dysexecutive function theory suggests that ASD individuals have impairments in various cognitive abilities such as planning, inhibition, self-monitoring, and cognitive flexibility (Hill, 2004; Ozonoff & Jensen, 1999; Verté, Geurts, Roeyers, Oosterlaan, & Sergeant, 2006). Deficits in attention have been a particular focus of research recently, with numerous studies providing evidence of abnormal attention in ASDs, such as impairments in shifting attention (e.g., Belmonte, 2000; Happé, Booth, Charlton, & Hughs, 2006; Plaisted, Swettenham, & Rees, 1999; Townsend, Harris, & Courchesne, 1996). Although impairments in attention have been found in ASD individuals, it is important to note that these individuals are often capable of paying obsessive attention to non-social stimuli. This implies that inattention to the social cues, and not inattention in general, is impaired. This suggests that a core difficulty these individuals experience is linked to motivation (i.e., lack of motivation to interact with social stimuli), rather than top-down processes.

Theories of this kind have been proposed in an attempt to identify a single primary deficit which can account for the various profiles of *cognitive* strengths and weaknesses in autism (Pellicano, 2007). However, despite the popularity of the ToM theory of autism and evidence of ToM deficits in ASD individuals, roughly 20% of ASD individuals do develop some ToM skills (Happé, 1994; Rajendran & Mitchell, 2007). Furthermore, inconsistent findings suggest that it is unlikely that specific executive functions or attention are uniquely deficient in autism (Hill, 2004; Hill & Bird, 2006; Pellicano, Maybery, Durkin, & Maley, 2006; Pennington & Ozonoff, 1996). It is therefore argued that the various ASD profiles often demonstrate several co-existing deficits in top-down processes, and that no one universal top-down process can account for the various presentations seen in these individuals (see Rajendran & Mitchell, 2007).

ToM skills, intact executive functioning, and being able to pay attention hold obvious advantages in social and emotional interactions. The role of top-down processes in regulating empathic behaviour is reflected, for example, in the finding that high-functioning autistic individuals are more able to function in a social environment as opposed to their lower-functioning counterparts (e.g., Frith, 2004; Ghaziuddin, 2008; Rajendran & Mitchell, 2007; Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007). This implies that higher-functioning ASD individuals can compensate with their cognitive abilities. It seems that, to a certain degree, the top-down (cognitive) processes involved in relating can compensate for the impairments in bottom-up processes of relating. As various ASD profiles in terms of top-down impairments exist, those top-down processes which are intact in higher-functioning individuals facilitate learning about appropriate social-emotional behaviour to a certain degree. In contrast, their lower-functioning counterparts do not have the ability to do so.

Bottom-up processes. ASDs are often described as disorders of social-emotional relatedness (e.g., Bachevelier & Loveland, 2006; Wing & Gould, 1979; Rogers, Herbison, Lewis, Panlone, & Reis, 1986; Scrambler, Hepburn, Rutherford, Whener, & Rogers, 2007). This description implies that the processes involved in relating to others on an social and affective level (i.e., viscerally sharing others' emotions) are impaired. Much attention has been directed at top-down processes when accounting for the difficulties ASD individuals experience. As a result, we have a reasonable understanding of their difficulties with these processes. The bottom-up difficulties, however, are less clearly understood. The lack of attention to the bottom-up difficulties comes as a surprise.

Hobson (1993) has argued that deficits in higher-order abilities such as ToM and executive functioning are allocated too much responsibility for the deficits evident in ASDs. He argues that we are neglecting the innate difficulties with social interaction exhibited by these individuals, and that more attention should be directed at their more basic deficits or difficulties in relating to others. Impairments in bottom-up empathic processes pervade the ASDs, while it is possible for some ASD individuals to engage in cognitive empathic processes (Happé, 1994; Rajendran & Mitchell, 2007). Rogers and colleagues (2007), for example, demonstrate that Asperger's individuals have a high ability to engage in top-down empathic processes, but struggle with bottom-up empathic processes.

In line with this, Yimiya and Sigman (2001) argue that those diagnosed with an ASD struggle specifically with behaviours which require working models of the self, the other, and how these relate. In other words, they struggle with behaviours that depend on self-other differentiation; they struggle with the very basic and innate processes involved in relating to another individual on a visceral level: bottom-up processes of relating.

Empathy, ASDs, and gender. It is a well-established fact that males are more likely than females to be diagnosed with a disorder on the autism spectrum. Recent figures suggest that males are 4 times more likely than females to be diagnosed with an ASD, and 9 times more likely to be diagnosed with AS (Ingudomnukul et al., 2007; Kogan et al, 2009. Gender differences have understandably been, and remain, a major focus of autism research, as they could elucidate a or *the* illusive cause of ASDs.

Attention was drawn earlier to the differences in empathic behaviour across genders. Literature suggests that sex differences in maturational processes of the brain are linked to differences across genders in empathic behaviour. As deficits in empathy are a defining characteristic of ASDs, it follows that the connection between empathy, gender, and ASDs, might be able to tell us something about what causes autism. As a result of these differences, two major theories (not unrelated) have emerged to explain the differences in behaviour seen across the genders, namely the 'extreme male brain' hypothesis of autism, and the androgen theory of autism.

The extreme male brain hypothesis of autism. The extreme male brain hypothesis of autism, proposed by Baron-Cohen (2002), has received much attention, and continues to generate much research. According to Baron-Cohen, an individual with a *female brain* tends to exhibit emotion-oriented behaviours more readily than someone with a *male brain*, and therefore scores higher on empathizing ability (i.e., empathizing refers to the ability to recognize and respond emotionally to another individual). In contrast, an individual with a *male brain*, tends to exhibit systems-oriented behaviours more readily than those with a *female brain*, and therefore score higher on systemizing ability (i.e., systemizing refers to the drive to understand how systems work). The essential difference lies in motivation: Behaviour is driven by either motivation to interact socially and/or emotionally (i.e., the female brain) or motivation to understand a system (i.e., the male brain).

In other words, the female brain more naturally motivates empathic behaviour, and the male brain is inclined to behaviour reflecting an interest in how systems work. Baron-Cohen argues that not all males have a male brain and not all females necessarily have a female brain, but it is more likely for this to be the case. Importantly, ASD individuals have what Baron-Cohen refers to as an 'extreme male brain', in that they have below average empathizing ability and intact or even superior systemizing ability.

The androgen theory of autism. A second theory linked to gender differences is the androgen theory of autism. This theory proposes that increased an increased level of foetal testosterone in amniotic fluid "contributes to differences in brain development that underlie the cognitive traits found in autism" (Baron-Cohen & Wheelwright, 2004; Geschwind & Galaburda, 1985, p. 2). Although other factors significantly contribute to the development of the brain, the level of foetal testosterone in the amniotic fluid is recognized as playing a critical role in the differences found in brain structures across sexes (Arnold, 1996; de Vries et al., 2002; Fitch & Denneberg, 1998). Specifically, its effect on the development of the hypothalamus, the limbic system, and neocortical structures has been noted (Arnold & Gorski, 1984; Breedlove, 1994; MacLusky & Naftolin, 1981).

Aside from effects on the physical development of the brain, Knickmeyer and colleagues (2005) provide evidence for a correlation between prenatal testosterone levels and empathy-related behaviours in typically developing four year olds. For example, higher foetal testosterone levels were associated with poorer quality of social relationships. Knickmeyer and colleagues (2005; 2006) further provide some convincing evidence linking testosterone levels in amniotic fluid to autistic behaviour. This is supported by the finding that higher foetal testosterone levels are associated with poorer quality of social relationships (Knickmeyer et al., 2005), a core feature of ASDs.

The Phenomenon of Cradling Bias

The human preference to cradle an infant to the left of the body midline is a well-established social phenomenon (Salk, 1960; Harris, 2010). When cradling an infant with the sole intention of soothing it or putting it to sleep, a leftward bias is seen. This phenomenon is particularly prevalent in females, regardless of age or prior parenting experience, with roughly 75 % of females exhibiting the leftward cradling bias (de Chateau, 1983; Manning & Chamberlain, 1991; Saling & Bonert, 1983; Salk, 1960). Although it is less pronounced in males, it is still present, and becomes more pronounced in males with parenting experience (Bourne & Todd, 2004; Turnbull & Lucas, 1996). The leftward cradling bias has furthermore been reported regardless of the method employed for measurement (i.e., whether the cradling situation is imagined, performed, or observed in photographic materials), and has also been reported in all cultures and historical periods investigated to date (de Chateau & Anderson, 1976; Harris, Spradlin, & Almerigi, 2006; Manning & Chamberlain, 1991; Nakamichi & Takeda, 1995; Richards & Finger, 1975; Saling & Cooke, 1984; Vauclair & Donnot, 2005).

Aside from its occurrence in humans, cradling bias is also seen in various higher primates (Hopkins, 2004; Manning & Chamberlain, 1990). For example, a clear leftward bias, similar to that found in female human beings, has been found in chimpanzees, and gorillas (Manning & Chamberlain, 1990; Manning, Heaton, & Chamberlain, 1994; Nishida, 1993). Together, the above-mentioned findings suggest a biological basis for cradling bias, as well as possible evolutionary significance of cradling an infant to the left.

Defining cradling. The context within which holding occurs (e.g., feeding, soothing, or transporting) influences side preference (Donnot, 2007). When referring to cradling bias the differentiation from functional cradling must be made clear; functional cradling is defined as “cradling-while-doing-something-else” (van der Meer & Husby, 2006, p. 263), as opposed to holding an infant in the cradling position with the sole purpose of interacting with it (non-functional cradling). In addition to this, the *type* of interaction (i.e., soothing vs stimulating) can also influence cradling side, as rightward cradling is often seen in stimulating interactions (Reissland, 2000; Sieratzki & Woll, 2002).

Much of the literature fails to define cradling adequately – a crucial flaw in a number of studies that have investigated the leftward cradling bias in the past. For example, Nakamichi (1996) investigated holding patterns in an indigenous people from Madagascar, and found a rightward holding bias in this population. However, Nakamichi’s definition of cradling included functional cradling scenarios. Furthermore, many, such as Donnot (2007), investigate ‘holding bias’, albeit non-functional, and not cradling bias. As the side preferred can be explained in terms of the context within which holding occurs, it is imperative that studies investigating cradling bias be specific about how they define this phenomenon. The current research was concerned with non-functional cradling bias; specifically, it was concerned with the leftward bias evident when an infant is cradled with the sole intention of soothing it or putting it sleep.

Early explanations for the leftward cradling bias

The heartbeat hypothesis. Several explanations have been proposed for this phenomenon, among which the heartbeat hypothesis was the first to emerge (Salk, 1960;

Weiland, 1964). Salk proposed that the mother's heartbeat has a soothing effect on the infant as a result of the soporific effect of the experience *in utero*. As the heartbeat is more audible on the left side, the leftward bias is consequently seen. Salk (1973) further argued that this in turn results in better feeding of the infant, as well as a less-distressed infant. This theory has been criticized from several angles. For example, Querleu and Renard (1981) question whether the heartbeat can be heard *in utero*. Furthermore, Bundy (1979) points out that the heartbeat can be heard regardless of the cradling side, as long as the infant's ear is pressed directly against the mother's skin. Overall, direct evidence for the heartbeat hypothesis and the beneficial effects it is argued to afford is lacking (Palmqvist, 1975).

The handedness hypothesis. A second early explanation for the leftward cradling bias was the notion that cradling bias is influenced by handedness (Huheey, 1977; Salk, 1973). As the laterality of handedness is well-established, the rationale behind this hypothesis was that cradling bias can be explained by the evolutionary advantage it held, because the dominant hand would be free to perform other tasks (Huheey, 1977). It is established that handedness is a determining factor in functional cradling (van der Meer & Husby, 2006). However, investigation into the phenomenon of non-functional cradling bias has revealed that individuals prefer cradling to the left of the body midline regardless of their dominant hand (Bourne & Todd, 2004; Manning & Chamberlain, 1991). This once again highlights the need to clearly define the context within which cradling occurs when investigating the phenomenon of cradling bias.

Salk (1960) points out that side preference is often rationalized according to an individual's dominant hand. For example, left-handed individuals who cradle to the left explain side of preference as a result of their left arm being stronger to support the infant. In contrast, right-handed individuals who cradle to the left tend to explain their preference as a result of their dominant hand being free to perform important tasks. Manning and Chamberlain (1991) further point out that a rightward cradling bias has not been found in left-handed individuals. In fact, Donnot (2007) investigated cradling bias in left-handed students and mothers, and found that these individuals also demonstrate the leftward cradling bias. In sum, numerous studies support the argument that the effect of handedness on non-functional cradling bias is negligible at best (Bourne & Todd, 2004; Harris, Almerigi, & Kirsch, 2000; Manning & Chamberlain, 1991).

The role of emotion in cradling

Early cerebral explanations. The heartbeat and handedness hypotheses are two explanations which have received much attention in the past, but they are by no means the only explanations for the occurrence of the leftward cradling bias. More recently, cerebral explanations, based on the right hemisphere's critical role in emotion processing, have been put forth (Blonder, Bowers, & Heilman, 1991; George et al., 1996; Ross & Monnot, 2008). Specifically, cradling bias has been linked to the right hemisphere's role in the perception and expression of emotions. These explanations assert that placing the infant in the caregiver's left visual and/or auditory field/s allows for optimal interpretation of the infant's emotions. The more expressive side of the mother's face is then, in turn, presented back to the infant (Borod, Haywood, & Koff, 1997; Bourne & Todd, 2004; Campbell, 1982; Manning & Chamberlain, 1991). In other words, these explanations suggest that the underlying function of cradling bias is that it allows for optimal monitoring of emotional states and, consequently, for optimal caregiver-infant interactions.

Although it is credible that leftward cradling would allow for optimal emotional processing, empirical investigations into these explanations have not proven supportive. For example, Lucas and colleagues (1993; 1996) found no significant correlation between cradling side and right hemisphere functions such as visual perception of emotions. Furthermore, if these cerebral explanations were correct, it would be expected that the number of right cradlers (roughly 25%) match up with the number of individuals with atypical hemispheric dominance for emotional processing (roughly 5-10%; Gainotti, 1997; Harris, 2010), which is not the case. However, a point to bear in mind is that it is possible that, as a result of inconsistent definitions of cradling bias used in different studies to date, estimates of cradling bias are inaccurate. Until consistent definitions are employed when determining the occurrence of cradling bias, a cerebral explanation cannot be excluded.

The effect of emotional states on cradling bias. A recent review of the literature by Harris (2010) provides a comprehensive discussion of the various explanations presented for this bias. In this review, Harris highlights the influence of certain emotional states in the caregiver on cradling side. For example, a decline in leftward bias, sometimes to the point of reversal of this bias, has been found in anxious and stressed caregivers (Reissland, Hopkins, Helms, & Williams, 2009; Suter, Huggenberger, & Schächinger, 2007). In line with this, Suter and colleagues (2007) demonstrated a decline in leftward cradling when stress was induced in caregivers. Reissland et al.'s (2009) findings supported this. In addition to this, there have been mixed findings regarding cradling bias in mothers who were depressed, with some finding a continued leftward bias, and others supporting a reduction or absence of leftward cradling bias in these mothers (Reissland et al., 2009; Suter et al., 2007; Weatherill et al., 2004). Findings thusfar, although mixed, indicate that the caregiver's emotional state can influence cradling side.

Weiland and Sperber (1970) conducted an experiment in which they asked individuals to hold a pillow against their chests, and subsequently hold the pillow as if it were an infant they were soothing or comforting. No preference was found upon the first instruction, but a leftward bias was present when trying to soothe a 'distressed' infant. Their findings were originally interpreted as an example of how emotions are linked to cradling side. However, an important point to note here is that the leftward bias emerged as soon as a relationship (i.e., an imaginary 'caregiver-infant' relationship) was implicated between the participant and the pillow. These findings suggest that the underlying mechanism of cradling bias concerns the caregiver-infant relationship. Specifically, as one's emotional state can affect one's interactions with others, these findings suggest that cradling is linked to the quality of the caregiver-infant interaction and subsequent relationship (e.g., Vauclair & Donnot, 2005; Weatherill et al, 2004).

Cradling bias and the quality of the caregiver-infant interaction and relationship. As a result of the above-mentioned lines of thinking, the notion that cradling bias is linked to the quality of the caregiver-infant interaction and subsequent relationship has emerged. This hypothesis, based on hemispheric asymmetry for emotional communication and right hemisphere dominance for social attachment and communication behaviour, has received much support. Several studies have illustrated overall poorer quality of caregiver-infant interactions in rightward cradlers (e.g., Bogren, 1984; de Chateau, Holmberg, & Winberg, 1978). For example, rightward cradlers tend to engage in less physical contact with their infants than leftward cradlers, and also tend to express fewer feelings of affinity to their infants.

Similarly, rightward cradling has been linked to poorer quality of the caregiver-infant relationship (i.e., attachment; Bogren, 1984; Turnbull & Collins, 2000). In fact, de Chateau and colleagues (1978) viewed rightward cradling as an early indicator of a non-optimal caregiver-infant relationship. Turnbull and Collins (2000), for example, investigated cradling bias in a group of mothers attending a clinic; attending this clinic suggested some difficulties in the mother-infant relationship. Not only was a rightward bias present, but those mothers who cradled to the right were also more 'detached' from and less responsive to their infant than the leftward cradlers. Overall, research suggests that cradling is associated with the quality of the caregiver-infant interaction and relationship.

Cradling bias and relating. Bowlby (1969) and Ainsworth (1979) explain the relationship between caregiver (mother) and infant in terms of basic needs for survival. The caregiver-infant relationship is vital in maintaining the infant's physical well-being (i.e., basic physical needs such as food and protection), as physically, the infant is unable to look after itself, and therefore relies on the caregiver for survival. Importantly, the caregiver-infant relationship also plays a crucial role in maintaining psychological wellbeing; for one, the infant learns how to relate to others from her/his primary caregiver, as the first relationship an infant forms, serves as a template for future relationships (referred to as a working model). The caregiver-infant bond provides a secure base from which the infant can interact with the world. The working model established in this early relationship therefore informs the way in which the infant will relate to others in future (Main, Kaplan, & Cassidy, 1985). As human beings are "intrinsically social" (Cacioppo, 2002, p. 819), how we relate is an important facilitator of effective social functioning, which in turn has implications for our survival as a species.

The cradling scenario provides a situation in which the caregiver and infant can interact and communicate with one another. This interaction allows for the development of a relationship between caregiver and infant[4]. The literature provides good reason to suspect that the leftward bias emerges as a consequence of an unconscious mechanism. For one, the leftward bias is present in some higher primates who do not possess the higher-order abilities that humans do. Furthermore, this bias has been seen across genders, cultures, and historical periods. I thus argue that cradling bias taps into basic, intuitive bottom-up processes of relating.

Important to note is that this interaction relies on the *ability to relate* to another person. Fundamentally, the leftward cradling bias relies on the innate psychobiological capacity to readily interact and form relationships with others. In line with this, Chateau and colleagues (1982) that "right-holding might be associated with a reduced willingness or ability to become emotionally involved with the infant" (p. 421).

[4] A point to bear in mind is that often emphasis is placed on how the caregiver affects the relationship, while the infant's contribution to this relationship is often neglected (Ainsworth, 1979; Bowlby, 1969). Both caregiver and infant play active roles in developing the relationship. In fact, Bowlby points out that at times the infant 'forces' the caregiver to respond in certain ways. Both individuals play a role in the development of a relationship.

Autism spectrum disorders and cradling bias. Recall that ASDs are characterised by deficits in empathy, and that more specifically, autism is often described as a disorder of social-emotional relatedness (e.g., Bachevelier & Loveland, 2006; Baron-Cohen, 1989; Baron-Cohen et al., 1985; de Bildt et al., 2005; Gillberg, 1992; Hermans, van Wingen, Bos, Putman, & van Honk, 2009; Rogers et al., 1986; Scrambler et al., 2007). Implicit in this description is the notion that these individuals struggle to relate to others. These individuals often struggle with both top-down processes of relating, but without exception, experience difficulties with bottom-up processes of relating. As the literature suggests that cradling bias taps into bottom-up processes of relating, investigating cradling bias in ASDs provides one way in which the difficulties these individuals encounter when engaging in bottom-up processes of relating can be illustrated.

Rationale for Research

Deficits in empathy are considered a defining feature of ASDs (e.g., Baron-Cohen, 1989; Baron-Cohen et al., 1985; de Bildt et al., 2005; Gillberg, 1992; Hermans, van Wingen, Bos, Putman, & van Honk, 2009). As Decety and Lamm (2006) explain, a "crucial aspect of empathy" (p.1146) is that it concerns the ability to relate to others. The ability to relate facilitates empathic behaviour, which in turn leads to the formation of social and emotional relationships. Important to note is that empathic behaviour involves both top-down and bottom-up processes. In terms of ASD, these individuals experience impairments in both top-down and bottom-up empathic processes. Their difficulties in top-down empathic processes are relatively clear, whereas we have a relatively poor understanding of their impairments in bottom-up processes.

Furthermore, autism is a known disorder of social-emotional relatedness (e.g., Bachevelier & Loveland, 2006; Rogers et al., 1986; Scrambler et al., 2007; Wing & Gould, 1979). Implicit in this description is the notion that these individuals' ability to relate to others emotionally is impaired. This is evidenced, for example, in their difficulties in establishing reciprocal relationships, and is echoed in Kanner's (1943) original description of autistic individuals as "having come into the world with an innate inability to form the usually biologically provided affective contact with other people (p.250)." While it is possible for high-functioning ASD individuals to utilize top-down processes to relate to others (e.g., Frith, 2004; Ghaziuddin, 2008; Rajendran & Mitchell, 2007; Rogers et al., 2007), impairments in bottom-up processes are implicated in Kanner's description. Research focussing on their more basic difficulties with social reciprocity (i.e., bottom-up processes of relating) is lacking. This draws attention to the need to direct more attention towards understanding and investigating the impairments in bottom-up processes.

Investigating the occurrence of cradling bias in provides an opportunity to investigate the functioning of bottom-up processes of relating. When cradling an infant with the sole purpose of soothing it or putting it sleep, a leftward cradling bias is universally present. The literature indicates that this bias is facilitated by a capacity for empathy, and links it to an enhanced quality of the caregiver-infant relationship. The literature furthermore provides good reason to suspect that this bias taps into basic, intuitive bottom-up processes involved in relating.

Summary of Research Goals

The aim of this research was to begin to examine the deficits in bottom-up processes of relating experienced in ASDs by investigating the occurrence of cradling bias in children diagnosed with disorders on the autism spectrum. The long-term goal is to obtain a clearer understanding of the nature of deficits in bottom-up processes of relating in ASDs, which would have implications for treatment and management of these individuals.

The literature concerning cradling bias in ASDs is limited to one unpublished thesis (Mark, 2002). This study investigated cradling bias in 25 girls diagnosed with disorders on the autism spectrum. Findings from this study suggest that cradling bias may be absent in the ASD population, but given the methodological flaws present (e.g., the absence of a control group) no firm conclusions can be drawn. As a result, to investigate the occurrence of this phenomenon in ASD children, a methodologically sound investigation of cradling bias was employed.

In addition to this, I wanted to more firmly exclude the involvement of top-down processes in cradling bias. Although there is ample evidence to support the notion that cradling bias taps into bottom-up processes, the influence of top-down processes on cradling bias has yet to be investigated empirically.

This research consisted of a pilot and a main study. The purpose of the pilot was to explore the occurrence of cradling bias in ASD children when employing a methodologically sound design, before further investigation continued. The following hypotheses were addressed in both the pilot and the main studies:

1. The leftward cradling bias will be absent in individuals diagnosed with ASDs.
2. Cradling bias will not be influenced by intellectual and executive functioning (i.e., top-down processes).

Recall that empathy is thought to be associated with bottom-down processes of relating and cognitive with top-down processes. As the main study included a measure of Cognitive and Affective empathy, an additional hypothesis was addressed:

3. Cradling bias will be influenced by Affective empathy.

Method

Research Design and Setting

This research consisted of two studies: a pilot study and a main study. Both studies were cross-sectional comparisons of two groups: an ASD group and a Control group. For both studies, the method employed to collect data was quasi-experimental, as participants were divided into groups based on the pre-existing criterion of diagnosis (i.e., ASD and Control). The ASD groups (i.e., for both studies) included children diagnosed with low-functioning autism (LFA), high-functioning autism (HFA), Asperger's syndrome (AS), and pervasive developmental disorder-not otherwise specified (PDD-NOS). For the pilot, the Control group consisted of only typically developing (TD) children, whereas for the main study, the Control group consisted of TD as well as mentally handicapped (MH) children[5].

Testing took place at the various schools involved in this research or at participants' homes, depending on which was preferred by the parent/guardian. Furthermore, parents, teachers or personal facilitators were given the opportunity to observe the administration of tests and tasks. A quiet room, free of distractions, was used as the test setting.

Participants

Participants were recruited from the Western Cape and Gauteng provinces. Both convenience sampling and snowball sampling were employed. ASD and MH children were recruited from autism-specific and special needs' schools, and TD children were recruited from mainstream schools. ASD participants were also recruited via contacting autism support groups, and additionally, existing participants' parents were asked to identify other potential suitable candidates.

All ASD participants were diagnosed, according to the DSM-IV-TR criteria, by a qualified independent clinician. Those diagnosed with autistic disorder were further characterized according to IQ as low-functioning (LFA) or high-functioning (HFA). Participants in the HFA group had an IQ of 75 and above, while those in the LFA group had an IQ of below 75. MH participants met the DSM-IV-TR criteria for Mild Mental Retardation, with an IQ of between 55 and 70 (see Appendix B for the full diagnostic criteria for Mental Retardation).

[5] A portion of the Control group included MH children; these children were included in the Control group as controls for the LFA children (i.e., to control for the possible influence of deficits in intellectual and/or executive functioning).

Pilot study. Twenty children (age range 6-14 years) diagnosed with an ASD participated in the pilot study. Twenty TD children within a similar age range (5-14 years) constituted the Control group. The groups were perfectly matched on age, gender, and home language (see Table 1). Matching on age and gender was imperative, as these two variables are known to influence cradling bias (Bourne & Todd, 2004; Harris, 2010; Rueckert & Naybar, 2008). Participants were not matched on ethnicity, as cradling bias is not considered to be a culture-specific phenomenon (Manning & Chamberlain, 1991; Richards & Finger, 1975; Saling & Cooke, 1984). Demographic characteristics of the pilot participants are presented in Table 1.

Table 1

Demographic Characteristics of the Pilot Study Sample

Characteristic	Group	
	ASD (*n* = 20)	Control (*n* = 20)
Age range (years: months)	6:3-14:8	5:10-14:6
Age (years)		
M (*SD*)	10.52 (2.56)	10.70 (2.62)
Gender		
Male: female	14: 6	14: 6
Home language		
English: Afrikaans	14: 6	14: 6
Ethnicity		
White: black: coloured	16: 1: 3	17: 0: 3
Handedness		
Left: mixed[a]: right	1: 1: 18	0: 0: 20

Note. ASD = autism spectrum disorder

[a] Mixed-handedness refers to ambidexterity.

Main study. Sixty children (age range 6-16 years) diagnosed with an ASD participated in the main study; 15 LFA, 15 HFA, 15 AS, and 15 PDD-NOS. The Control group consisted of 25 TD children and 15 MH children within a similar age range (6-15 years). Across the groups participants were matched as closely as possible on age and gender.

The final sample for the main study, however, consisted of 53 ASD participants and 40 Control participants, as seven ASD participants were excluded from the study (for reasons to be addressed shortly). Although groups remained well-matched on age, as a result of these exclusions, groups were no longer perfectly matched on gender. Demographic characteristics of the final main study participants are presented in Table 2. (See Table A in Appendix G for demographic characteristics of the various ASD and Control subgroups in the main study).

Table 2

Demographic Characteristics of the Main Study Sample

Characteristic	Group	
	ASD (*n*=53)	Control (*n*=40)
Age range (years: months)	6:5-16:2	6:4-15:1
Age (years)		
M (*SD*)	10:19 (2.43)	10.46 (2.67)
Gender		
Male: female	9: 44	9: 31
Home language		
English: Afrikaans: other	44: 4: 5	27: 5: 8
Ethnicity		
White: black: coloured	32: 6: 15	11: 10: 19
Handedness		
Left: mixed: right	1: 13: 39	1: 5: 34

Inclusion and exclusion criteria[6]. Both male and female participants were recruited. Basic comprehension (i.e., comprehension of instructions for tasks assessing pretend play ability, handedness, motor dexterity, and cradling bias) in either English or Afrikaans was a minimum requirement for participation. Participants were included on condition that they were able to correctly complete two-stage verbal instructions as well as pass tasks of pretend play.

Additional information necessary for determining exclusion was obtained through completion of the demographic questionnaire. Exclusion criteria for the TD group included a history of head injury and/or infantile meningitis. TD and MH participants diagnosed with any neurological condition/s, as well as ASD participants diagnosed with any additional neurological condition/s, were excluded from the study. Additionally, a diagnosis or history of behavioural disorders (e.g., conduct disorder, oppositional-defiant disorder), attentional disorders (e.g., attention-deficit/hyperactivity disorder), a developmental disorder, affective disorders, psychotic disorders, and/or substance abuse, resulted in exclusion from the TD group.

[6] These criteria were employed in both the pilot study and the main study.

No participants were excluded from the pilot study. In the main study, however, 5 LFA children and 2 PDD-NOS children failed tasks assessing pretend play and were therefore excluded from this study. (The significance of pretend play competence will be discussed shortly).

Ethical considerations. This research formed part of a broader research project for which ethical approval was granted. It followed the guidelines for research with human subjects as outlined by the Health Professions Council of South Africa (HPCSA) and the University of Cape Town Codes for Research. The relevant Education Departments granted permission to recruit participants from public schools in their regions. Permission was subsequently obtained from the schools involved to approach their students to participate in the research. Parents/guardians provided written informed consent for their children's participation, and on the day of assessment, the children provided assent to participate (Appendix C).

Parents were assured that anonymity would be maintained, that all data would be kept confidential and be used for research purposes only, and that video-tapes of sessions would be viewed by the principal researcher only. Participants were not exposed to any risk. If they experienced fatigue at any point, they were allowed to rest between tasks. Participants and parents/guardians were also made aware that if at any point they wished to do so, they could withdraw from the study, without any negative consequences. Following completion of the research, written feedback regarding each child's performance was sent to their parents/guardians and schools were given feedback regarding their students' participation.

Measures

The tasks and tests administered to each participant depended on two factors, namely (1) which study he/she participated in (i.e., pilot or main study), and (2) individual participant characteristics (e.g., being unable to read or being non-verbal impacted on which tasks and tests could be completed; see *Procedure*). Table 3 provides a summary of all measures employed in this research.

Table 3

Summary of Measures Employed

Measure	Domain assessed
Comprehension of Instructions task [a]	Basic comprehension of instructions
Pretend Play task	Ability to engage in pretend play
Cradling Bias task	Cradling bias
WPPSI-R/WASI	General intellectual functioning [b]
D-KEFS	General executive functioning [c]
Control tasks	Includes tasks assessing handedness, motor dexterity, and the ability to engage in pretend play
Griffith's Empathy Measure	Cognitive and Affective empathy

Note. WPPSI-R = Wechsler Preschool and Primary Scale of Intelligence; WASI = Wechsler Abbreviated Scale of Intelligence; D-KEFS = Delis-Kaplan Executive Function System.
[a] Taken from the NEPSY-II. [b] Performance IQ was used as proxy for general level of intellectual functioning. [c] The Colour-Word Interference task, taken from the D-KEFS, was selected to assess general executive functioning.

The Comprehension of Instructions task, Pretend Play task, and Cradling Bias task, as well as tests assessing intellectual and executive functioning were employed in the pilot study.

For the main study, a set of Control tasks and the Griffith's Empathy Measure were added to the pilot protocol. In addition to this, the Cradling Bias task employed in the pilot study was adjusted for the main study.

Comprehension of instructions. The Comprehension of Instructions task taken from the NEPSY-II (Korkman, Kirk, & Kemp, 2007) was employed to assess basic comprehension of English or Afrikaans. This task assesses the ability to receive, process, and execute oral instructions of increasing syntactic complexity. Participants were required to correctly complete at least two-stage verbal instructions for the inclusion criterion of basic comprehension to be met.

Pretend play. The Pretend Play task tested the ability to use a doll as an independent agent in a pretend situation. Participants were asked to complete four stories by acting out simple scenarios using the dolls provided. This task was modified from the original described by Kavanaugh, Eizenmand, and Harris (1997). The original task was judged to be female-gender stereotyped, as all stories required that children act out scenarios depicting mother-infant interactions (e.g., a mother feeding her baby). As the majority of children diagnosed with ASDs are boys, stories were changed to depict gender-neutral events, which would be appealing to both male and female participants (e.g., feeding a dog; for the original and adapted tasks, see Appendix D).

It was imperative that all participants successfully completed this task, as the Cradling Bias task requires the ability to engage in a pretend scenario. The ASD children's performances were of particular interest as these individuals are known to have deficits in pretend play (e.g., Charman et al., 2000; Steele, Joseph, & Tager-Flusberg, 2003). Controlling for this potential confound was crucial, as deficits in pretend play would undermine findings of a task (i.e., the Cradling Bias task) which relies on the ability to engage in a pretend scenario. Therefore, if ASD participants passed the Pretend Play task, it could be argued that any group differences found in cradling would not simply be a reflection of difficulties with engaging in pretend play. TD children were not expected to fail the Pretend Play task, as they begin to engage in pretend play from 14 to 24 months (Frith & Frith, 2003), and participants were above this age. Nevertheless, it was confirmed that they too passed this task before administering the Cradling Bias task.

Cradling bias. The protocol utilized for the Cradling Bias task was adopted from one employed in a study by Mark (2002). This task required that the participant hold a doll in the cradling position on a number of separate occasions. The participant was asked to hold the doll as if it were an infant she/he wanted to soothe or put to sleep. Thus, the participant had to engage in a pretend scenario.

Pilot study. Cradling bias was observed on three separate occasions. For the first of the three trials, the researcher introduced the participant to the doll saying, "This is Suzie. Suzie is very tired. Will you hold Suzie, like you are putting her to sleep?" The researcher then presented the doll in an upright position at the participant's midline. For each of the remaining trials the researcher reintroduced the child to Suzie, told him/her that Suzie was tired again, and asked him/her to put Suzie to sleep again. In the case that the participant did not hold the doll in the cradling position, the researcher demonstrated the cradling position (see Figure 1 below), being careful not to demonstrate a particular side, and said, "Hold Suzie in this way." The researcher distracted the participant for approximately 1 minute between trials by making conversation about his/her daily activities.

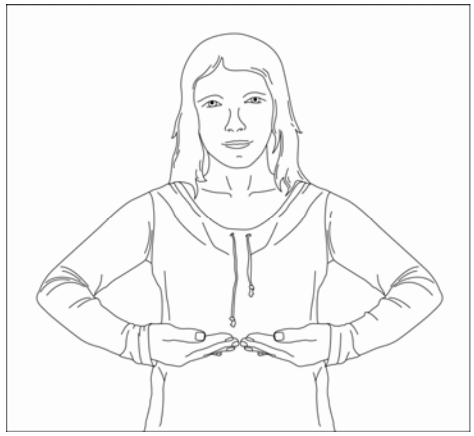

Figure 1. Demonstration of the cradling position. The researcher was careful to not suggest a particular side; as is illustrated, the researcher faced forward, and her arms were held in such a way that neither arm was favoured.

Cradling side was determined by the visual field (of the child) in which the doll's face lay (i.e., left or right). Cradling *bias* was determined by the preferred side of cradling observed across the trials (i.e., the side preferred on two or all trials). Three independent trials were used to ensure that the preference was a stable and a reliable source of data.

Cradling bias was treated as a continuous variable (i.e., as a degree of bias). For each trial where the participant cradled to the left, -1 was coded; and for each to the right, +1 was coded. Thus, if the participant cradled to the left on all three trials, a score of -3 was allocated. If the participant cradled to the left twice and to the right once, a score of -1 was coded. The degree of cradling bias therefore ranged from -3 to 3. For descriptive analysis, cradling bias was categorically coded as either Rightward or Leftward. It was furthermore characterised as either Consistent (i.e., same side across all trials) or Inconsistent cradling (i.e., switched sides across trials).

Main Study. A fourth trial was added to the pilot protocol for the main study. This trial was added because administering 3 trials does not allow for the possibility of having no bias (i.e., cradling an equal number of times on either side). The instructions given to participants and the manner in which cradling side was determined remained unchanged from that of the pilot. Accordingly, cradling bias was determined by the preferred side of cradling observed on three or all trials. As in the pilot, for each leftward cradle, -1 was coded, and +1 for each cradle to the right. The degree of cradling bias therefore ranged between -4 and 4. Cradling bias was subsequently categorically coded for descriptive analysis as either Rightward or Leftward and furthermore characterised as either Consistent or Inconsistent, depending on whether any switches occurred.

In addition to this, performances on the Cradling Bias task for the main study were video-taped to assess whether any observable qualitative differences or similarities in cradling were evident across groups. Several recurring behaviours were noted during performance of the Cradling Bias task in the pilot study. These behaviours drew attention to differences in the quality of the interaction between child and doll across groups. As a result, I looked out for these behaviours when analysing video-tapes of the Cradling Bias task in the main study.

It is important to note that these video-tapes were not analysed rigorously: I did not employ a rating scheme and did not make use of independent raters (i.e., video-tapes were viewed and analysed by the principal researcher only). Because of this, any observations noted as well as any interpretations made are preliminary, and should be treated as such. They do, however, add some insight into the quality of the cradling interaction. This insight, although preliminary, is valuable, as cradling bias is associated with the *quality* of the caregiver-infant interaction and subsequent relationship. Qualitative observations can therefore tell us a little more about the difficulties these individuals experience in relating to others.

Intellectual and executive functioning. To address the possible influence of intellectual and executive functioning on cradling bias, participants were administered tests assessing these domains. Although these tests were not developed in South Africa or normed for the South African population, the interpretation of results should not be affected, as groups were compared to their peers (i.e., their respective Control groups).

Intellectual functioning. The *Wechsler Preschool and Primary Scale of Intelligence* (WPPSI-R; Wechsler, 1999) was used to assess intellectual functioning of participants below the age of 6 years; the *Wechsler Abbreviated Scale of Intelligence* (WASI; Psychological Corporation, 1999) was administered to participants aged 6 years and older.

The WPPSI-R has been standardized for children between the ages of 2 years 11 months and 7 years 3 months. It is comprised of seven subtests, three of which, namely Mazes, Geometric Design and Block Designs, were administered to assess Performance IQ (PIQ). The WASI is a standardized and robust measure of intellectual functioning, normed for individuals between the ages of 6 and 89. It is comprised of four subtests, two of which, namely Block Design and Matrix Reasoning, were administered to assess PIQ.

PIQ was used as proxy of general level of intellectual functioning (rather than verbal or full-scale IQ). This decision was based on the rationale that poor language ability is often present in ASDs, at times to the extent that these individuals are non-verbal. It was therefore possible that not all participants recruited would have been able to complete a measure of verbal IQ. To avoid excluding these non-verbal children, a measure of intellectual functioning which all participants could complete was utilized, namely PIQ.

Executive functioning. *The Delis-Kaplan Executive Function System* (D-KEFS; Delis, Kaplan, & Kramer, 2001) is a standardized measure of key components of executive function (EF), normed for individuals between the ages of 8 and 89. It is comprised of nine tests, of which the Colour-Word Interference task was administered to obtain a measure of EF. This task, based on the Stroop (1935/1992) Test, assesses the ability to inhibit an over-learned verbal response. All participants above the age of 6 years (i.e., where the participants' characteristics, such as reading ability, allowed for this) completed this task.

In particular, the Inhibition/Switching Raw Score was selected from the Colour-Word Interference task as a measure of EF. This score represents the time taken to complete this task. The Inhibition/Switching Raw Score can be considered an indicator of cognitive flexibility (set-shifting) and inhibitory control (the ability to inhibit behaviour). Numerous studies have demonstrated that various aspects of executive functioning, including cognitive flexibility and inhibitory control, correlate with ToM performance (e.g., Carlson & Moses, 2001; Henry, Phillips, Crawford, Ietswaart, & Summers, 2006; Joseph & Tager-Flusberg, 2004; Ozonoff & Jensen, 1999; Sabbagh, Xu, Carlson, Moses, & Lee, 2006). Thus, selecting this score as a measure of EF addressed the possibility that cradling bias is related to both EF and ToM.

Empathy. The Griffith's Empathy Measure (GEM), a parent-report questionnaire designed to measure empathy in children, was employed (Dadds et al., 2008; Appendix E). The questionnaire consists of 23 statements to which the parent/guardian provides a yes or no response, on a scale from -4 (strongly disagree with the statement) to +4 (strongly agree with the statement). These items load on two different 'components' of empathy, namely Cognitive empathy (e.g., "It's hard for my child to understand why someone else gets upset," and "My child rarely understands why other people cry") and Affective empathy (e.g., "My child becomes upset when another person is acting upset" and "My child seems to react to the moods of people around him/her"). In other words, items are designed to tap into the child's capacity to *know* or *understand* what others are feeling on a cognitive level (Cognitive empathy) or their capacity to *feel* what others are feeling (Affective empathy). This measure is established to be a reliable and valid measure across gender and age (Dadds et al., 2008).

Control tasks

Pilot study. Handedness was determined by the parent's/legal guardian's indication on the demographic questionnaire. Participants were categorized as either left-handed, right-handed, or mixed-handed (i.e., ambidextrous). The ability to engage in pretend play was assessed via performance on the Pretend Play task.

Main study. Three simple tasks were employed to address possible influences on cradling bias, namely the influence of handedness, difficulties in motor skills, and the ability to engage in pretend play (in addition to the Pretend Play task). Participants were asked to perform three simple tasks, namely to write his/her name (or draw something if he/she could not write), to kick a ball, and to pretend that he/she is brushing his/her teeth. The Pretend Play task and the Control tasks were administered before the Cradling Bias task. This was done to establish whether a reason to discontinue testing existed (such as, for example, problematic motor skills).

Handedness was determined by the parent's/legal guardian's indication on the demographic questionnaire in conjunction with the side preferred to perform the above-mentioned unimanual tasks. Participants were categorized as either left-handed, right-handed, or mixed-handed. To be categorized as left- or right-handed, the participant had to consistently prefer one of these sides (i.e., according to his/her parent as well as on the 3 additional tasks).

The manner in which the participant kicked a ball, used a pencil, and brushed his/her teeth were observed to identify any issues surrounding voluntary motor ability which could have influenced which side the participant favoured, as well as the manner in which the doll was held when cradling.

As mentioned before, ASD individuals are known to have deficits in pretend play. Performing a task such as pretending to brush his/her teeth acted as an additional measure of the participant's ability to engage in a pretend scenario (i.e., in addition to the Pretend Play task described above).

Procedure

Pilot study. Written informed consent was obtained from the participants' parents/legal guardians before testing commenced. In addition to this, parents/guardians completed a demographic questionnaire (see Appendix F). The demographic questionnaire included information necessary for identification of children who met any of the exclusion criteria, as well as information pertinent to the selection of Control group participants (i.e., information necessary for matching of participants on age, gender, and home language). Written informed assent was obtained from the participant at the beginning of each session. Participants who were unable to write provided verbal assent.

The tests and tasks outlined in the *Measures* above were completed over one or two sessions, depending on the time available for testing and individual participant characteristics. Not all participants were able to complete all tests/tasks. For example, the ability to read was essential to complete the Colour-Word Interference task. Each session lasted between 20 and 90 minutes; this also depended on individual participant characteristics such as concentration span as well as the time available for testing.

During the first session, the Comprehension of Instructions task was administered first, followed by the Pretend Play task. Assessment continued on condition that the child could correctly complete two-stage instructions and correctly act out the four pretend scenarios using the dolls provided. The Cradling Bias task was administered next. Depending on the child's age, the WIPPSI-R or WASI Performance subtests were administered. The Colour-Word Interference task was then administered.

Main study. As in the pilot, informed consent and assent was obtained before testing commenced. For the main study, parents/guardians were required to complete the GEM in addition to the demographic questionnaire.

The two sessions were structured in a similar way as in the pilot, the only difference being the administration of the Control tasks after the Pretend Play task in session one. The control tasks were administered before the Cradling Bias task to establish whether a reason to discontinue testing existed (e.g., problematic motor skills). As in the pilot, following completion of the Cradling Bias task, the WIPPSI-R or WASI Performance subtests and the Colour-Word Interference task were administered.

Participants were allowed to rest if at any point they experienced fatigue during sessions. At the end of the final session the participant was adequately debriefed and thanked for participating. Parents/guardians received written feedback regarding their child's performance following completion of the research. Schools received feedback once all children recruited from their school had received individual feedback.

Data Analysis

All statistical analyses were completed using PASW Statistics version 18.0 (SPSS, 2010). The level for statistical significance was set at $\alpha = .05$.

For both the pilot and main study, to characterise between-group differences in sample characteristics, chi-squared analyses were performed on the categorical data (i.e., gender, home language, ethnicity, and handedness). Furthermore, independent-samples t-tests were employed for the continuous data (i.e., age, PIQ, EF, and additionally Affective and Cognitive empathy for the main study). Unless otherwise stated, all assumptions underlying the various tests employed were upheld.

For all pilot comparisons, ASD participants' performances were compared to their Control counterparts (i.e., TD children). Similarly, for all main study comparisons, with the exception of handedness, ASD participants' performances were compared to their Control counterparts (i.e., TD and MH children grouped together). In the main study, because differences in the distribution of handedness are expected in those with developmental delays, when investigating the possible influence of handedness on cradling bias, analysis compared the ASD group, the TD subgroup, and the MH subgroup.

Hierarchical multiple regression analyses were employed for both the pilot and the main study analyses. I hypothesized that whether or not an ASD diagnosis was present would be the main predictor of cradling bias. However, other factors might also impact. Thus, to investigate whether differences in gender, handedness, intellectual functioning, and executive functioning could explain the differences in cradling bias across the groups, these factors were included in the regression models.

Results

Pilot Study

Sample characteristics. The final sample for the pilot study consisted of 20 children diagnosed with an ASD (age range 6-14; 5 LFA, 6 HFA, 3 AS, 6 PDD-NOS) and 20 TD children (age range 5-14). The two groups (ASD and Control) were perfectly matched on age, gender, and home language (see Table 4). All participants were able to correctly complete at least two-stage verbal commands in either English or Afrikaans (e.g., “show me the small, happy bunny”) on the NEPSY-II Comprehension of Instructions task. Furthermore, all participants correctly acted out the four pretend scenarios with the dolls provided. Sample characteristics of the pilot participants are presented in Table 4.

Table 4
Sample Characteristics of the Pilot Study Sample

Characteristic	Group		Significance	
	ASD (n = 20)	Control (n = 20)	t / $\chi 2$	p
Age range (years: months)	6:3-14:8	5:10-14:6	-	-
Age (years)				
M (*SD*)	10.52 (2.56)	10.70 (2.62)	-2.14	0.862
Gender				
Male: female	14: 6	14: 6	.00	1.00
Home language				
English: Afrikaans	14: 6	14: 6	.00	1.00
Ethnicity[a]				
White: black: coloured	16: 1: 3	17: 0: 3	-	-
Handedness[a]				
Left: mixed: right	1: 1: 18	0: 0: 20	-	-
Intellectual functioning [b]				
M (*SD*)	79.05 (14.69)	102.40 (14.81)	-5.01	<.001*
Executive Functioning [c]				
M (*SD*)	109.87 (30.97)	79.71 (21.25)	3.25	.001**

[a] Chi-squared analyses were not performed on these data, as it would not be possible to meaningfully interpret the results due to the presence of empty cells. [b] Performance IQ was used as a measure of intellectual functioning. [c] A high score for executive functioning indicates poor performance, as this score reflects the time taken to complete the Colour-Word Interference task. Five ASD participants could not complete this task; 3 were unable to read, and 2 were non-verbal. Three Control participants were unable to read (they were too young) and therefore could not complete this task.

*$p < .001$. ** $p = .001$.

Handedness. The distribution of handedness did not differ from what is seen in a typically developing population.[7] No overt differences could be seen in the distribution of handedness between the two groups. Apart from 1 left-handed ASD child and 1 mixed-handed ASD child, all other children (both ASD and Control) were right-handed. A chi-squared analysis was not performed on this data, as due to the presence of empty cells it would not be possible to meaningfully interpret the result.

General intellectual functioning. Performance IQ (PIQ) was used as a measure of general intellectual functioning. PIQ scores of the Control children were consistent with established Western population norms. An independent-samples *t*-test revealed a statistically significant between-group difference in, $t(38) = -5.01$, $p < .001$, $d = -1.58$, with ASD children scoring significantly lower ($M = 79.05$, $SD = 14.69$) than their Control counterparts ($M = 102.40$, $SD = 14.81$).

General executive functioning. Participants were compared on their performances on the Colour-Word Interference task taken from the D-KEFS. In particular, the Inhibition/Switching Raw Scores were compared. This score was selected from the Colour-Word Interference task as a measure of EF as it can be considered an indicator of cognitive flexibility (set-shifting) and inhibitory control (the ability to inhibit behaviour, both of which are known correlates of ToM. In this way, the possibility that cradling bias is related to both EF and ToM was addressed (see *Measures*). Raw scores, rather than standardised scores, were used to compare performances as some participants were younger than eight years (the age from which normative scaling starts). Comparing raw scores was possible because participants were well-matched on age.

An independent-samples *t*-test revealed a statistically significant between-group difference in EF, $t(30) = 3.25$, $p = .001$, $d = 1.14$, with ASD children performing significantly more poorly ($M = 109.87$, $SD = 30.97$) than their Control counterparts ($M = 79.71$, $SD = 21.25$). Note that a higher score indicates slower (poorer) performance.

Cradling bias. For descriptive analysis (as illustrated in Figure 2), cradling bias was treated as a categorical variable; it was coded as either Rightward or Leftward, depending on the side preferred on the majority of trials, and was furthermore characterised as either Consistent (i.e., cradled to the same side across all trials) or Inconsistent cradling (i.e., switched sides across trials).

[7] A J-shaped distribution is expected in a typically developing population; most people strongly prefer the right, few strongly prefer the left, and almost none show no preference (see Annett, 1970).

The differences in cradling bias across the ASD and Control groups are illustrated in Figure 2. A leftward bias was evident in the Control group compared to no bias in the ASD group. Ninety percent of the Control children preferred to cradle to the left, compared to 50% of the ASD children. Cradling side was therefore chosen at chance level by ASD children. Furthermore, whereas almost all (90%) Control children consistently cradled to one side across the three trials, fewer than half (45%) of the ASD children did so.

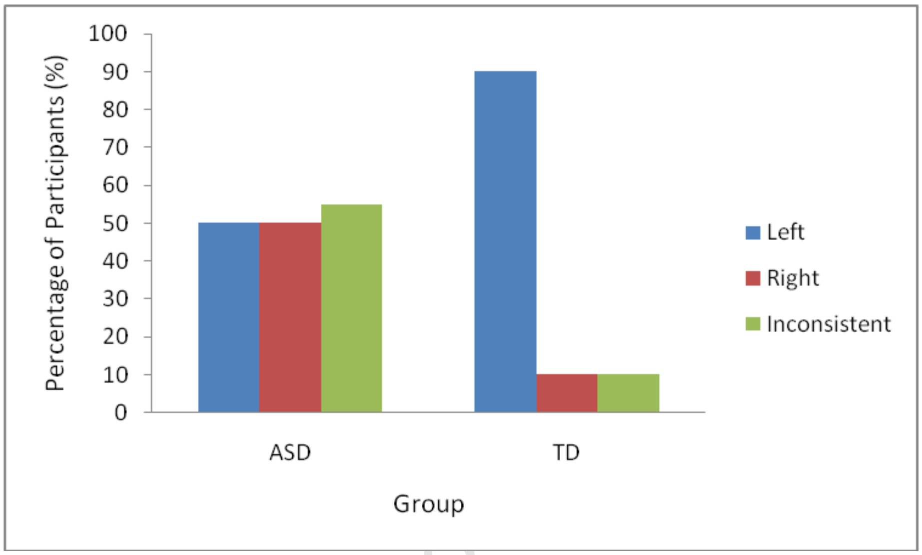

Figure 2. Comparison of left and right cradling across the ASD and Control groups. Percentage of inconsistent cradlers indicated. As can be seen, cradling side was chosen at a level no greater than chance in the ASD group, with more than half of the ASD children cradling inconsistently. In contrast, a strong leftward bias can be seen in the Control group, with almost none of these children cradling inconsistently.

For inferential analyses (i.e., the regression analysis to follow), cradling bias was treated as a continuous variable (i.e., as a degree of bias). For each trial where the participant cradled to the left, -1 was coded and for each to the right, +1 was coded. For example, a score of -3 therefore indicates leftward preference on all three trials. A score of 1 would indicate that the participant cradled to the right twice and to the left once.

A hierarchical multiple regression analysis was conducted to examine the relationship between *Cradling bias* and various potential predictors. *Gender* was entered first, as the literature suggests the possibility of a relationship between this variable and *Cradling bias*. Ideally, *Handedness* would be entered after this. However, as only 1 participant was left-handed and 1 was mixed-handed, any correlation between *Handedness* and *Cradling bias* would likely be an artefact of the skewed nature of the distribution of handedness within this sample. As a result, Handedness was left out of this model. *Intellectual functioning* (i.e., *PIQ)* and *Executive functioning* (*EF*) were therefore entered next (separately), to investigate possible effects they might have on *Cradling bias*. *Group* was entered last as it was expected that the group the participant belonged to (ASD vs Control) would have an effect over and above the influence of *Gender*, *Intellectual functioning,* and *EF.* Furthermore, the nature of the groups (i.e., significantly lower PIQ and poorer EF in the ASD group compared to the Control group) dictated that *PIQ* and *EF* would correlate with *Group*. In addition to this, intellectual and executive functioning are known to be correlated with each other (e.g., Henry et al., 2006; Joseph & Tager-Flusberg, 2004; Ozonoff & Jensen, 1999; Sabbagh et al., 2006). Hence, to assess whether interactions between *PIQ* and *EF* (*PIQ*EF)*, *PIQ* and *Group* (*PIQ*Group)*, and *EF* and *Group* (*EF*Group)* were further contributing to explaining *Cradling bias*, these interactions were added as potential predictors after *Group*.

Table 5

Intercorrelations Between Potential Predictor Variables and Cradling Bias (Pilot Study)

	Cradling Bias	Gender	PIQ	EF	Group
Cradling Bias	-	-.01	-.20	-.12	-.40*
Gender		-	.15	-.12	.19
PIQ			-	-.47*	.61**
EF				-	-.51*
Group					-

*$p < .05$. ** $p < .001$.

The intercorrelations table (Table 5) indicated that the only significant correlation between a predictor variable and the outcome variable was the moderate correlation between *Group* and *Cradling bias,* $r = -.40$, $p = .012$. Furthermore, as expected (i.e., due to the nature of the groups) some moderate significant correlations were found between *PIQ* and *EF*, $r = -.47$, $p = .003$, *PIQ* and *Group*, $r = .61$, $p < .001$, and *EF* and *Group*, $r = -.51$, $p = .001$.

The results of the regression indicated that the inclusive model was not significant, $F(7, 24) = 1.98$, $p = .100$, $R^2 = .37$. *Group* was identified as the only significant predictor of *Cradling bias*, $\beta = -.72$, $p = .005$ (see Table 6). From the Model Summary table (Table 7) it is evident that the addition of *Group* to the regression model created a significant change in R^2, $p = .008$, by uniquely explaining 20.9% of the variance in *Cradling bias*. Results thus suggested that a one-variable restrictive model, with only *Group* as predictor of *Cradling bias* would be better than the original inclusive model.

Table 6

Coefficients Table for Inclusive Regression Model (Pilot Study)

Model	Coefficients B	Coefficients *SE*	Coefficients Beta	*t*	*p*
Constant	9.34	12.19		.77	.451
Gender	.47	.96	.08	.49	.630
PIQ	-.12	.12	-.86	-.96	.345
EF	.04	.07	.53	.64	.532
Group	-3.42	1.10	-.72	-3.12	.005*
PIQ*EF	.88	.70	.35	1.25	.222
PIQ*Group	1.22	1.30	.80	.94	.355
EF*Group	-1.84	1.45	-1.10	-1.27	.215

* $p < .01$

Table 7

Model Summary Table[h] (Pilot Study)

Model	*R*	R^2	*SEE*	Change statistics $\triangle R^2$	$\triangle F$	*df1*	*df2*	*sig.*$\triangle F$
1[a]	.01	.01	2.45	.01	.01	1	30	.978
2[b]	.20	.04	2.44	.04	1.20	1	29	.282
3[c]	.32	.10	2.40	.06	1.88	1	28	.181
4[d]	.56	.31	2.14	.21	8.18	1	27	.008*
5[e]	.56	.31	2.18	.01	.03	1	26	.869
6[f]	.57	.32	2.21	.01	.49	1	25	.491
7[g]	.61	.37	2.18	.04	1.62	1	24	.215

[a] Predictor: Gender

[b] Predictors: Gender, PIQ

[c] Predictors: Gender, PIQ, EF

[d] Predictors: Gender, PIQ, EF, Group

[e] Predictors: Gender, PIQ, EF, Group, PIQ*EF

[f] Predictors: Gender, PIQ, EF, Group, PIQ*EF, PIQ*Group

[g] Predictors: Gender, PIQ, EF, Group, PIQ*EF, PIQ*Group, EF*Group

[h] Dependent variable: Cradling bias

*$p < .01$

A regression analysis using only *Group* as predictor of *Cradling bias* was subsequently run, and yielded a significant result, F (1, 38) = 9.31, p = .004. The significant moderate relationship between *Group* and *Cradling bias*, r = -.44, p = .002, explained 17.6 % of the variance in *Cradling bias.* TD children were significantly more likely to cradle to the left (M = -2.30, SD = 1.84) than their ASD counterparts (M = -.15, SD = 2.30), who exhibited almost no bias (i.e., a negative score indicated left bias, a positive indicated right bias, and a score of 0 represented no bias).

Main Study

Sample characteristics. All participants were able to correctly complete at least two-stage verbal commands in either English or Afrikaans (e.g., "show me the small, happy bunny") on the NEPSY-II Comprehension of Instructions task. However, not all participants (i.e., 5 LFA and 2 PDD-NOS children) were able to correctly act out all pretend scenarios with the dolls provided, and were thus excluded. The final sample for the main study consisted therefore consisted of 53 children diagnosed with an ASD (age range 6-16; 10 LFA, 15 HFA, 15 AS, and 13 PDD-NOS), and 40 Control children (age range 6-15; 25 TD and 15 MH). Despite the exclusions, groups were still matched on age. Sample characteristics of the final main study participants are presented in Table 8.

Gender. Although participants were initially matched on gender, as a result of the above-mentioned exclusions, as well as the difficulty in finding female ASD participants, the groups were no longer perfectly matched on gender. Eighty-three percent of the ASD group children were male compared to 77.5% of the Control group children. Chi-squared analysis was therefore employed to investigate whether the difference in the proportion of girls across the two groups was significant. The analysis indicated that this difference was not statistically significant, χ^2 (1, n = 93) = .45, p = .510.

Handedness. The distribution of handedness within the ASD, MH, and TD groups differed from what is seen in a typically developing population. [8] In line with what is expected from a typically developing population, most children in the TD group (i.e., 23 children) were right-handed. None were left-handed; however, more TD participants than expected were mixed-handed (i.e., 2). Interestingly, a similar trend emerged in the MH and

[8] The distribution of handedness in individuals with developmental disorders such as autism as well as the intellectually deficient differs markedly from that seen in the typically developing population. Compared to the typically developing population, these individuals are more likely to be left- or mixed-handed (for examples, see Bakan, Dibb, & Reid, 1973; Colby & Parkison, 1977; McManus & Cornish, 1997; Pipe, 1988; Soper et al., 1986). The Control group was therefore split into MH and TD groups for this analysis, and comparisons were made between three groups (i.e., ASD, MH, and TD).

ASD groups, with most children being right-handed, few left-handed, and more than expected being mixed-handed. Within the MH group 11 participants were right-handed, 3 mixed-handed, and 1 left-handed. Within the ASD group, 39 participants were right-handed, 13 mixed-handed, and 1 was left-handed.

Chi-squared analysis was employed to investigate whether the differences in the distribution of handedness seen across the ASD, MH, and TD groups were significant. Results indicated no significant difference in the distribution of handedness across the three groups, χ^2 (2, n = 93) = 5.18, p = .210, Fisher's Exact Test.

Table 8

Sample Characteristics of the Main Study Sample

Characteristic	Group		Significance	
	ASD (n = 53)	Control (n = 40)	t / $\chi2$	p
Age range (years: months)	6:5-16:2	6:4-15:1	-	-
Age (years)				
M (SD)	10.19 (2.43)	10.46 (2.67)	-.66	.51
Gender				
Male: female	9: 44	9: 31	.45	.41
Home language				
English: Afrikaans: other	44: 4: 5	27: 5: 8	3.13	.197
Ethnicity				
White: black: coloured	32: 6: 15	11: 10: 19	10.10	.006*
Intellectual functioning				
M (SD)	86.87 (18.73)	86.53 (21.71)	.08	.468
Executive functioning [a]				
M (SD)	108.54 (36.57)	85.50 (30.23)	2.59	.006*
Affective empathy				
M (SD)	3.85 (12.87)	10.88 (11.80)	-2.55	.007*
Cognitive empathy				
M (SD)	-3.86 (8.9)	4.33 (9.27)	-4.31	< .001**

[a] Twelve ASD participants and 13 Control participants could not complete this task (reasons addressed below).

* p < .01. ** p < .001.

General intellectual functioning. As in the pilot, Performance IQ was used as a measure of general intellectual functioning. An independent-samples t-test revealed no significant between-group difference in PIQ between the ASD group and the Control group, $t(91)$ = .08, p = .468. PIQ scores of ASD children were similar (M = 86.87, SD = 18.73) to those of their Control counterparts (*M* = 86.53, *SD* = 21.71). Note that this is the result of comparing an overall ASD group to the combined Control group (which included MH children as controls for the LFA children). Differences between the various ASD subgroups as well as between the TD and MH Control subgroups can be seen in Figure 3. The LFA subgroup and MH Control subgroup performed similarly (i.e., were well-matched) and the higher-functioning ASD subgroups (i.e., HFA, AS, and PDD-NOS) performed similarly to the TD Control subgroup.

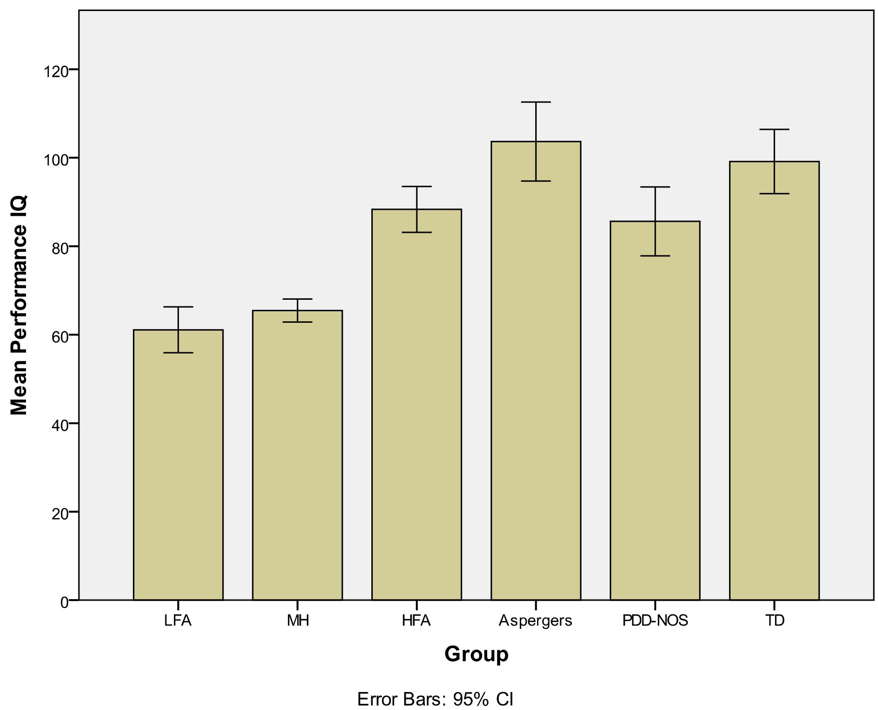

Figure 3. Differences in Performance IQ across the ASD and Control subgroups. As is evident, the low-functioning autism subgroup performed equivalently to the MH Control participants, and the various other ASD subgroups performed equivalently to the TD Control subgroup. Overall, the ASD and Control groups were thus well-matched on PIQ.

General executive functioning. As in the pilot, The Inhibition/Switching Raw Score, taken from the Colour-Word Interference task from the D-KEFS, was used as measure of general executive functioning (for reasons addressed earlier). Again, raw scores, rather than standardised scores, were used to compare performances as some participants were younger than eight years (the age from which normative scaling starts). Comparing raw scores was possible because participants were well-matched on age.

Sample sizes were smaller because of participants who could not read or were non-verbal. Twelve ASD participants could not complete the Colour-Word Interference task, of which 6 were lower-functioning (i.e., PIQ < 75), 4 were unable to read, and 2 were non-verbal. Thirteen Control participants could not complete this task, of which 11 were lower-functioning (i.e, MH; PIQ <75), and 5 were unable to read (i.e., they were too young and thus had not yet learnt how to read). The analysis was therefore run with data of all participants who could complete this task.

An independent-samples *t*-test revealed a statistically significant between-group difference in EF between the ASD and Control groups, $t(61) = 2.59$, $p = .006$, $d = .69$, with ASD children performing significantly more poorly ($M = 108.54$, $SD = 36.57$) than their Control counterparts ($M = 85.50$, $SD = 30.23$).

Empathy. According to Dadds et al. (2008), the Griffith's Empathy Measure serves as a measure of empathy. Specifically, items of this self-report questionnaire are said to reflect the child's ability to know or understand what others are feeling on a cognitive level (referred to as Cognitive empathy) or their ability to feel what others are feeling (referred to as Affective empathy). Nine items were identified as indicators of Affective empathy and 6 items were identified as indicators of Cognitive empathy (see Table B in Appendix G). An Affective empathy score was calculated by adding ratings for the 9 Affective empathy items. Similarly, a Cognitive empathy score was calculated by adding ratings for the 6 Cognitive empathy items.

Two independent samples *t*-tests were employed to investigate differences in Affective empathy as well as Cognitive empathy between the ASD and Control groups. Analysis revealed a significant between-group difference in Affective empathy scores between the ASD and Control groups, $t(91) = -2.55$, $p = .007$, $d = -.54$, with the ASD group scoring significantly lower ($M = 3.85$, $SD = 12.87$) than the Control group ($M = 10.48$, $SD = 11.80$). The difference in Cognitive empathy scores between the ASD and Control groups was also statistically significant, $t(91) = -4.31$, $p < .001$, $d = -.90$, with the ASD group again scoring significantly lower ($M = -3.86$, $SD = 8.90$) than the Control group ($M = 4.33$, $SD = 9.27$).

These results compare the overall ASD group to the combined Control group. Differences between the various ASD subgroups as well as between the Control subgroups are illustrated in Figures 4 and 5. As can be seen in Table 9, the MH and TD Control subgroups scored higher than all ASD subgroups on both Affective and Cognitive empathy.

Table 9

Mean Cognitive and Affective Empathy Scores Across ASD and Control Subgroups

Subgroup	*n*	Empathy	
		Cognitive	Affective
LFA	10	-5.20 (6.65)	3.60 (14.55)
HFA	15	-3.80 (10.54)	2.40 (8.71)
AS	15	-5.63 (8.50)	2.53 (15.29)
PDD-NOS	13	-.85 (9.28)	7.23 (13.42)
TD	25	7.16 (7.45)	11.88 (11.61)
MH	15	-.40 (10.29)	6.70 (12.78)

Note. Means presented with standard deviations in parentheses.

Although these results reflected expected differences (i.e., ASD group/subgroups scoring lower than Control group/subgroups), a closer look at the data raised concerns about the reliability and validity of the Griffith's Empathy Measure as a measure of empathy. A major concern was the substantial heterogeneity in both Affective empathy (bottom-up) and Cognitive empathy (top-down) scores within both the ASD and Control subgroups, which was highlighted by large standard deviations (see Table 9, Figure 4, and Figure 5). Although some variation is always expected, the *extent* to which scores varied was cause for concern. For example, as ASDs are a disorder characterised by impaired Affective empathy (i.e., bottom-up processes), substantial variation in Affective empathy scores as reported was not expected in the ASD group. Raising further concerns was the fact that a number of LFA parents reported higher Affective scores for their children than did many of the TD parents. Possible reasons for this variation will be addressed at a later stage. This substantial variability suggested that the means, despite reflecting expected differences, were not a good summary statistic.

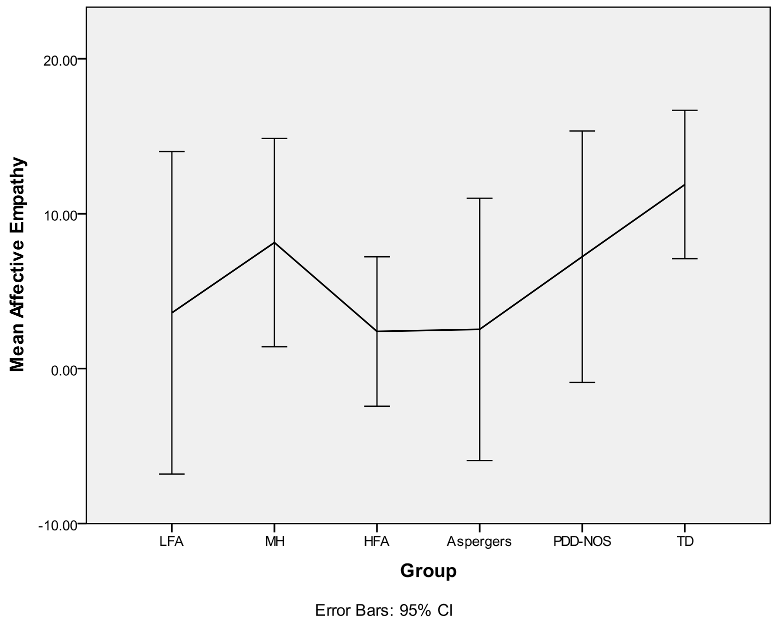

Figure 4. Mean Affective empathy scores across the ASD and Control subgroups. As can be seen, Affective empathy scores in all ASD subgroups (i.e., LFA, HFA, AS, and PDD-NOS) were lower than both the MH and TD Control subgroups.

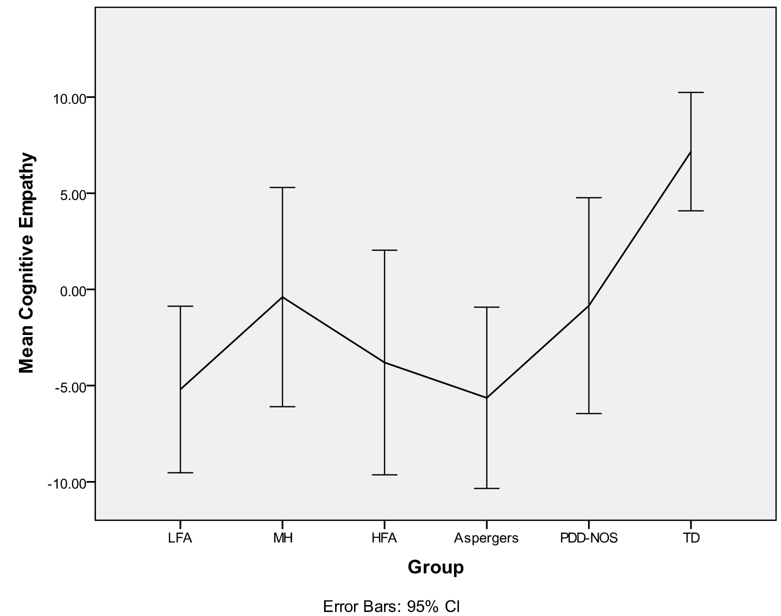

Figure 5. Mean Cognitive empathy scores across the ASD and Control subgroups. A similar trend as is seen in Affective empathy scores is emerges, with ASD subgroups scoring lower than the Control subgroups.

Cradling bias. A leftward bias was evident in the Control group, with 82.5 % of these children preferring to cradle to the left. In comparison, cradling bias was absent in the ASD group, with 48% of these children preferring to cradle to the left. As in the pilot, cradling side was chosen at chance level by ASD children. Furthermore, whereas almost no (7.5%) Control children cradled inconsistently across the four trials, almost a quarter (22.6 %) of the ASD children did so. Figure 6 illustrates the differences in cradling bias between the ASD and Control groups, and the differences in cradling bias across the ASD and Control subgroups are illustrated in Figure 7.

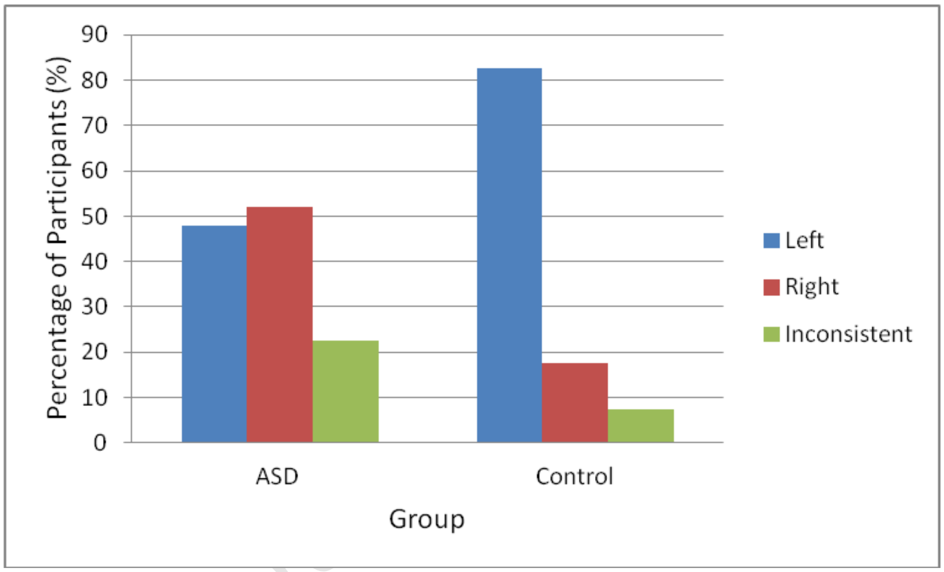

Figure 6. Comparison of left and right cradling across the ASD and Control groups. Percentage of inconsistent cradlers indicated. From this figure it is clear that cradling side was chosen at a level no greater than chance in the ASD group, whereas a strong leftward bias can be seen in the Control group. Furthermore, almost a quarter of the ASD children (22.6%) cradled inconsistently, whereas almost no Control children (7.5%) did so.

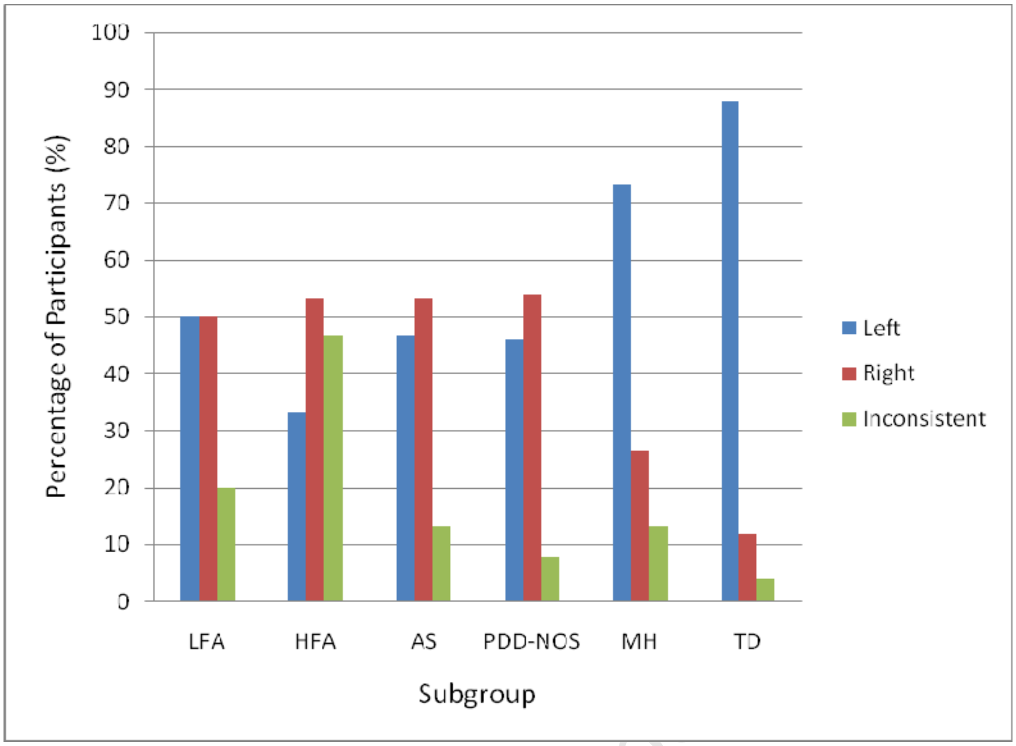

Figure 7. Comparison of left and right cradling across the ASD and Control subgroups. Percentage of inconsistent cradlers indicated**.** As can be seen, a leftward bias was evident in both the MH and TD subgroups, with 73% of the MH subgroup cradling to the left and 88% of the TD subgroup cradling to the left. In contrast, no clear bias can be identified across the various ASD subgroups.

As in the pilot study, a hierarchical multiple regression analysis was conducted to examine the relationship between *Cradling bias* and various potential predictors. The rationale for building the model in the main study was the same as that of the pilot study. *Gender* and *Handedness* were entered first. *Intellectual functioning* (i.e., *PIQ)* and *Executive functioning* (*EF*) were entered next (separately). Ideally, *Affective* and *Cognitive empathy* would be entered (separately) after this. However, given concerns regarding the reliability of these scores (to be discussed below), I decided to exclude these variables. Following this, *Gro*up was entered. To assess whether interactions between *PIQ* and *EF* (*PIQ*EF)*, *PIQ* and *Group* (*PIQ*Group)*, and *EF* and *Group* (*EF*Group)* were further contributing to explaining *Cradling bias*, these interactions were added as potential predictors after *Group*.

The intercorrelations table (Table 10) indicated that the only significant correlation between a predictor variable and the outcome variable was the moderate correlation between *Group* and *Cradling bias,* $r = -.30$, $p = .009$. Furthermore, as expected (i.e., due to the nature of the groups) some moderate significant correlations were found between *PIQ* and *EF*, $r = -.22$, $p = .043$, and *EF* and *Group*, $r = -.32$, $p = .006$.

Table 10

Intercorrelations Between Potential Predictor Variables and Cradling Bias (Main Study)

	Cradling bias	Gender	Right	Left	PIQ	EF	Group
Cradling bias	-	-.15	-.16	.15	-.19	.05	-.30*
Gender		-	.10	.25**	-.18	-.11	.09
Right			-	-.31*	.01	-.08	.23**
Left				-	-.01	.01	-.10
PIQ					-	-.22**	.11
EF						-	-.32*
Group							-

**p* < .01. ** *p* < .05.

The results of the regression indicated that the inclusive model was not significant, $F(9, 53) = 1.36$, $p = .232$, $R^2 = .19$. Not one variable was identified as a significant predictor of *Cradling side* (all p > .05; see Table 11). However, the addition of *Group* to the regression model created a change in R^2 which approached significance, $p = .052$, by explaining 6% of the variance in *Cradling bias* (see Table 12). This, together with the finding that *Group* and *Cradling bias* were significantly correlated, $r = -.30$, $p = .009$, strongly suggested that *Group* might in fact be a significant predictor of *Cradling bias*. It was possible that the significant correlations between *PIQ* and *EF* and *EF* and *Group* were masking the effect of *Group* on *Cradling bias*; this rationale was supported by low tolerance of *PIQ*, *EF*, and *Group* (see Table 11) in the inclusive model. Furthermore, the pilot study results strongly suggested that *Group* was a significant predictor of *Cradling bias*. It was therefore possible that a one-variable restrictive model, with only *Group* as predictor of *Cradling bias* would be better than the original inclusive model.

Table 11

Coefficients Table for Inclusive Regression Model (Main Study)

Model	Coefficients					
	B	*SE*	Beta	*t*	*p*	Tolerance
Constant	13.02	12.84		1.01	.315	
Gender	-2.03	1.23	-.22	-1.66	.104	.84
Right	-.45	1.43	-.04	-.31	.755	.84
Left	4.80	4.04	.16	1.19	.239	.82
PIQ	-.11	.13	-.57	-.83	.409	.03
EF	-.05	.08	-.44	-.61	.547	.03
Group	-.40	6.87	-.05	-.06	.953	.02
PIQ*EF	.01	.01	.59	.84	.405	.03
PIQ*Group	.01	.06	.04	.05	.963	.02
EF*Group	-.02	.03	-.26	-.51	.611	.06

Table 12

Model Summary Table[i] (Main Study)

Model	*R*	R^2	*SEE*	Change statistics				
				ΔR^2	ΔF	*df1*	*df2*	*sig.* ΔF
1[a]	.15	.02	3.70	.02	1.37	1	61	.247
2[b]	.26	.07	3.68	.04	1.37	2	59	.262
3[c]	.34	.11	3.62	.05	3.18	1	58	.080
4[d]	.34	.12	3.54	.01	.06	1	57	.808
5[e]	.42	.17	3.55	.06	3.95	1	56	.052
6[f]	.43	.18	3.57	.01	.63	1	55	.430
7[g]	.43	.18	3.60	.01	.04	1	54	.842
7[h]	.43	.19	3.62	.01	.26	1	53	.611

[a] Predictor: Gender

[b] Predictors: Gender, [Right, Left]

[c] Predictors: Gender, [Right, Left], PIQ

[d] Predictors: Gender, [Right, Left], PIQ, EF

[e] Predictors: Gender, [Right, Left], PIQ, EF, Group

[f] Predictors: Gender, [Right, Left], PIQ, EF, Group, PIQ*EF

[g] Predictors: Gender, [Right, Left], PIQ, EF, Group, PIQ*EF, PIQ*Group

[h] Predictors: Gender, [Right, Left], PIQ, EF, Group, PIQ*EF, PIQ*Group, EF*Group

[i] Dependent variable: Cradling bias

A regression analysis using only *Group* as a predictor of *Cradling* b*ias* was subsequently run, and yielded a statistically significant result, F (1, 91) = 12.09, p = .001. The significant moderate relationship between *Group* and *Cradling bias*, r = -.34, p = .002, explained 11.7 % of the variance in *Cradling bias.* TD children were significantly more likely to cradle to the left (M = -2.55, SD = 3.00) than their ASD counterparts (M = .00, SD = 3.83; a negative score indicated left bias, a positive indicated right bias, and a score of 0 represented no bias). These findings are in line with the pilot study findings.

Discussion

When cradling an infant with the sole intention of soothing it or putting it sleep (i.e., non-functional cradling), a leftward bias is seen in humans and in higher primates. The aim of this study was to investigate whether this universal leftward cradling bias was absent in children diagnosed with disorders on the autism spectrum, with the goal of drawing attention to the very basic difficulties in relating and social reciprocity pervading ASDs. With this aim in mind, the occurrence of cradling bias in ASDs will be discussed first. In light of these findings, the *deficits in empathy* (i.e., impairments in relating) said to characterize ASDs, will be discussed next. The limitations will then be discussed, and recommendations will be made for future research.

Summary and Implications of Results

Cradling bias in ASDs. I investigated whether the universal leftward cradling bias was absent in children diagnosed with ASDs. The literature suggests that the leftward cradling bias is associated with an enhanced quality of the caregiver-infant interaction and subsequent relationship. According to this reasoning, cradling bias taps into an individual's ability to relate to another; it taps into bottom-up processes of relating. More specifically, I argue that cradling bias is facilitated by the *innate/instinctive* bottom-up processes involved in readily interacting with others. As deficits in empathy (i.e., impairments in processes of relating) pervade all ASDs (e.g., Baron-Cohen, 1989; Baron-Cohen et al., 1985; de Bildt et al., 2005; Gillberg, 1992; Hermans, van Wingen, Bos, Putman, & van Honk, 2009), I hypothesized that the leftward cradling bias would be absent in ASD individuals.

The purpose of the pilot study was to explore the occurrence of cradling bias in ASD children when employing a methodologically sound design before further investigation continued. The literature concerning cradling bias in ASDs is limited to one study (Mark, 2002). Although findings from Mark's study suggest that cradling bias may be absent in the ASD population, no firm conclusions could be drawn from these findings as a result of certain methodological flaws. The pilot study improved on Mark's design by utilizing a control group, and perfectly matching participants on age and gender, two variables which are thought to influence cradling bias (e.g., Bourne & Todd, 2004; Turnbull & Lucas, 1996).

The pilot study compared the occurrence of cradling bias in 20 children diagnosed with ASDs to its occurrence in 20 typically developing (TD) Control children. Regression analysis revealed that the group to which the child belonged was a significant predictor of cradling bias, explaining 17.6 % of the variance in cradling bias. The leftward cradling bias was absent in ASD children: When cradling a doll as if it were an infant she/he were soothing or putting to sleep, ASD children (regardless of particular ASD diagnosis) did not prefer a specific side. In fact, the cradling side they chose occurred at a level no greater than chance, with exactly 50% of this group cradling to the left and 50% cradling to the right. In contrast to this, Control children demonstrated the expected leftward bias, with 90% of this group cradling to the left.

It is important to note that although a leftward bias was expected in the Control group, it was more pronounced than the 70-80% suggested by the literature. This may have been due to the relatively small size of the TD Control group (i.e., 20 children). Increasing the sample size may have resulted in a leftward bias closer to the expected figure. However, it is also possible that, as a result of inconsistent definitions of cradling used in different studies, estimates in the literature are inaccurate. As discussed earlier, it is imperative that studies investigating cradling bias be specific about how they define cradling bias, as the context within which holding occurs (i.e., functional vs. non-functional holding), and even the type of interaction (e.g., soothing vs. stimulating) can significantly influence cradling side (Donnot, 2007; Reissland, 2000; Sieratzki & Woll, 2002; van der Meer & Husby, 2006).

In the pilot, further confirmation of this absence of cradling bias in ASD children was evident in the inconsistency of their side cradled across the three trials. Fewer than half (45%) of the ASD children consistently cradled to one side across the three trials, whereas almost all (90%) Control children cradled consistently to one side. This finding implied that side preference was not fixed in more than half of the ASD children (i.e., they did not have a bias, leftward or rightward).

Although the pilot study employed a methodologically sound design, the main study improved on this design in a number of ways: In the main study, as additional control measures, a mentally handicapped (MH) subgroup was included in the Control group, and an additional set of Control tasks were employed. The MH subgroup were included as controls for the LFA children, to control for the possible influence of deficits in intellectual and/or executive functioning. The additional Control tasks were employed to better assess possible influences on cradling bias, namely the influence of handedness, problematic motor skills, and the ability to engage in pretend play. By administering these tasks before the Cradling Bias task, reasons for discontinuing testing could be established. Furthermore, a fourth trial was added to the Cradling Bias task, which allowed for the possibility of having no bias (i.e., cradling an equal number of times on either side). An additional measure (i.e., the Griffith's

Empathy Measure) was also employed in the main study. Performances on the Cradling Bias task were video-taped, which allowed the researcher to gain some insight (although preliminary) into the differences and similarities in the quality of the cradling interaction across groups.

The main study compared the occurrence of cradling bias in 53 children diagnosed with ASDs to its occurrence in 40 Control children (25 TD and 15 MH). The main study analyses yielded results similar to that of the pilot study: the group to which the child belonged was a significant predictor of cradling bias, explaining 11.7 % of the variance in cradling bias. As in the pilot study, the leftward cradling bias was absent in ASD children. Again, the side chosen to cradle occurred at a level no greater than chance, with 48% of the ASD group cradling to the left and 52% cradling to the right. As expected, Control children (both MH and TD) demonstrated the leftward bias, with 82.5% of this group cradling to the left. Consistent with the literature regarding the occurrence of the leftward cradling bias, 73.3% of the MH subgroup cradled to the left. As in the pilot, the leftward bias seen in the TD subgroup (88% cradled to the left) was more pronounced than expected. Again, it is possible that actual patterns or estimates of cradling bias have been obscured by inconsistent definitions of cradling used in different studies to date. Note, however, that leftward cradling bias figures in the pilot and main study Control children matches up with figures around typical hemispheric dominance (in line with a cerebral explanation for cradling bias).

In the main study, a fair amount of inconsistency in the side cradled across the four trials was seen in the ASD children. Roughly a quarter (22.6%) of the ASD children cradled inconsistently across the four trials. Although this figure was noticeably lower than that seen in the pilot study, it still differed markedly from the inconsistency of cradling bias (7.5%) seen in the main study Control group. It is possible that this discrepancy results from the difference in the size of the ASD group across studies (i.e., 20 vs. 53). This finding, however, still suggested that cradling side preference was not fixed in a quarter of the ASD children.

The first hypothesis, that the leftward cradling bias would be absent in ASDs, was supported by both the pilot and main study, with 50% of the pilot study ASD children and 48% of the main study ASD children cradling to the left. In contrast, the leftward cradling bias was clearly evident in the Control children, with 90% of the pilot study Control children and 82.5% of the main study Control children cradling to the left. The ASD population is the first human population in which the universal leftward cradling bias has been found to be absent. The universal occurrence of the leftward cradling bias suggests a biological basis for cradling bias, as well as possible evolutionary significance of cradling an infant to the left.

Furthermore, its presence in various higher primates, who do not possess the higher-order abilities, implicate bottom-up processes. I therefore argue that the absence of the leftward cradling bias in ASD children may reflect these individuals' impairments in intuitive/innate bottom-up empathic processes.

Qualitative aspects of cradling. Ainsworth (1979) argued that it is "how the mother holds her baby, rather than how much she holds him or her that affects the way in which attachment develops" (p. 934). The importance of the quality of the interaction, above quantity, is stressed. Quantitatively, results indicate an absence of cradling bias in ASDs, but qualitatively, individual observations can tell us a little more about the difficulties these individuals experience in relating to others.

Observations of the quality of the interaction between child and doll (i.e., caregiver and infant) during performance of the Cradling Bias task seem to be in line with my argument that the leftward cradling bias is facilitated by intuitive/innate bottom-up processes involved in relating. For example, when asked to cradle the doll, Control children (both TD and MH) immediately placed the doll in the cradling position and looked at its face, making eye contact. It seems that the instruction to cradle the doll in a sense triggered the instinctive response to readily interact and form a relationship with the doll. One can almost say that these children assumed the role of caregiver naturally. Control children interacted with the doll as if it were a real live infant.

The interaction between ASD child and doll, however, could often be described as awkward; ASD children sometimes held the doll at arm's length, and were often not interested in holding the doll. Furthermore, several ASD children held the doll against their chests (i.e., face against chest), and did not look at the doll when holding it (making no eye contact). A number of ASD children looked at the researcher or at something else in the room while holding the doll. These children seemed to engage with the doll in the same way they would engage with an inanimate object; they did not engage and respond to the doll as a social stimulus. While these observations are preliminary and should be interpreted with caution, these differences in the quality of the interaction within this cradling bias scenario between groups are in line with the difficulties ASD individuals experience when relating to others (i.e., their impairments in social and emotional reciprocity).

Findings thusfar were supportive of my first hypothesis. However, it was important that a number of potential alternative explanations for the absence of cradling bias in ASDs be addressed. Several control tasks were therefore employed to investigate the influence of potential confounds.

Control tasks. Basic comprehension in either English or Afrikaans was the first criterion for participation in both the pilot and the main study. All participants passed the Comprehension of Instructions task by correctly completing at least two-stage verbal instructions. A number of participants were low-functioning (i.e., MH, LFA, as well as some PDD-NOS), and establishing basic comprehension of instructions was therefore important. The differences in cradling across the groups were therefore not a reflection of poor comprehension of instructions.

Pretend play competence was a second vital criterion for participation in both the pilot and the main study. As the cradling bias task relies on the ability to engage in a pretend scenario, it would reasonable to argue that the absence of a leftward bias in the ASD children could be due to the deficits in pretend play often experienced by this population. However, many of the schools from which ASD participants were recruited focus much attention on teaching these children pretend play. Furthermore, all participants (both ASD and Control) had to pass the Pretend Play task. All participants correctly completed four stories by acting out simple scenarios using the dolls provided; they were able to pretend to water a plant, wash a car, brush a dog, and feed a dog. Furthermore, all participants were able to correctly demonstrate (by pretending) how they brush their teeth. They were thus judged able to engage in imaginative activity. I could therefore conclude with more confidence that the group differences in cradling were not simply a reflection of the difficulties ASD children experience in engaging in pretend play.

For participation in the main study, participants had to complete three additional Control tasks, which addressed the possibility that any issues surrounding voluntary motor ability influenced cradling bias (both side preference and the manner in which the doll was held). All participants wrote their name (or alternatively drew a picture[9]), kicked a ball, and imagined brushing their teeth. The manner in which participants completed these tasks reflected no difficulties or abnormalities in motor control in the ASD, TD, or MH children. Furthermore, no differences were seen across ASD and Control groups. It was therefore unlikely that the differences in cradling across the groups were a reflection of difficulties with motor dexterity.

The Control tasks thus addressed three potential major confounds, namely basic language comprehension, pretend play competence, and voluntary motor dexterity, thereby making it more likely that the differences in cradling bias seen across the groups were in fact

[9] Several MH and lower-functioning ASD children could not write their names, and therefore drew a picture instead.

a reflection of impairments in bottom-up empathic processes in ASDs. However, although findings thus far were supportive of my first hypothesis, I had to establish whether or not several other variables, namely gender, handedness, intellectual functioning, and executive functioning, could account for the differences seen in cradling bias across the groups.

Did gender influence cradling bias? A difference in the degree of leftward cradling bias has been established between the genders in TD individuals (i.e., women exhibit a more pronounced bias than men do; Bourne & Todd, 2004; Turnbull & Lucas, 1996). As both males and females participated in this research, investigating the possible influence of gender on cradling bias was important. To control for this, participants in the pilot study were perfectly matched on gender (as can be seen in Table 5 in the *Results* section). In the main study, however, as a result of several exclusions, groups were not perfectly matched on gender, with 83% of the ASD group comprised of males compared to 77.5% of the Control group. Although this difference was not statistically significant, I investigated whether gender could account for the differences in cradling bias across the groups. Analysis revealed that gender was not a significant predictor of cradling bias. Furthermore, no observable differences in the quality of the cradling bias interaction were evident across genders within either the ASD or the Control groups.

Did handedness influence cradling bias? Numerous studies support the argument that handedness plays a negligible role in non-functional cradling (Bourne & Todd, 2004; Harris, Almerigi, & Kirsch, 2000; Manning & Chamberlain, 1991). However, observations of the quality of the interaction between ASD children and the doll suggested that the task of cradling an infant was performed as if it were any other non-social task, such as brushing one's teeth, for example. A task such as brushing one's teeth, however, will likely be influenced by handedness, as one tends to use one's dominant hand when doing this. As ASD children performed the cradling bias task as if it were a task such as brushing one's teeth, which is heavily influenced by handedness, the argument could be made that handedness would influence non-functional cradling in ASD individuals. I therefore investigated whether handedness could account for the differences in cradling bias across the groups.

Although it was not possible to perform analyses on handedness data in the pilot study, no overt differences were seen in the distribution of handedness across the two groups. Aside from 1 left-handed ASD participant and 1 mixed-handed ASD participant, all other participants (both ASD and Control) in the pilot study were right-handed. In the main study, analyses investigating possible differences in handedness compared the ASD group, the TD Control subgroup, and the MH Control subgroup, as differences in the distribution of handedness are expected in individuals with developmental delays (for examples, see Colby & Parkison, 1977; McManus & Cornish, 1997; Pipe, 1988; Soper et al., 1986). Interestingly, the distribution of handedness within the ASD, MH, and TD groups differed from what is seen in a typically developing population, in that more participants than expected where mixed-handed in each of these groups. Despite this, no significant between-group differences in handedness were found in the main study, and further regression analysis excluded handedness as a predictor of cradling bias.

Did intellectual and/or executive functioning influence cradling bias? I investigated whether cradling bias was influenced by intellectual and/or executive functioning. According to the literature, the leftward cradling bias is associated with an enhanced quality of the caregiver-infant interaction and subsequent relationship; cradling bias is facilitated by an individual's ability to relate to another. As this leftward bias has been reported across all cultures and historical periods investigated to date (de Chateau & Anderson, 1976; Harris, 2010; Richards & Finger, 1975; Saling & Cooke, 1984), and is also seen in various higher primates (Hopkins, 2004; Manning & Chamberlain, 1990), who do not possess higher-order abilities, I argue that this phenomenon is facilitated by basic intuitive bottom-up processes of relating. I therefore hypothesized that cradling bias would not be influenced by intellectual and executive functioning (top-down processes). The impairments in intellectual and executive functioning, as seen in ASD and MH individuals, would therefore not be able to account for the differences in cradling bias across groups.

I thus expected to find that the leftward cradling bias would be absent in ASDs, as deficits in bottom-up processes of relating (i.e., social-emotional relatedness) pervade all ASDs. Additionally, I expected to find that the leftward cradling bias would still be present in MH children, despite significant impairments in intellectual and executive functioning, as bottom-up processes of relating should not be impaired in these children.

Impairments in intellectual and executive functioning are characteristic of ASDs (Joseph & Tager-Flusberg, 2004; Ozonoff & Jensen, 1999). These impairments were evident in the significant between-group differences in both the pilot and main study. In the pilot, ASD participants scored significantly lower on PIQ than their Control counterparts, and also performed significantly more poorly on the EF measure. Regression analysis revealed that cradling bias was not predicted by either intellectual or executive functioning.

In the main study, the difference in PIQ between the ASD and Control was not significant. Note that this was the result of comparing the ASD group to a Control group which included a MH and TD subgroup. The LFA and MH subgroups performed similarly (i.e., were well-matched) and the higher-functioning ASD subgroups (i.e., HFA, AS, and PDD-NOS) performed similarly to the TD subgroup, thus IQ was equated across the groups. Despite the inclusion of a MH subgroup, however, ASD participants performed significantly more poorly on the EF measure when compared to the Control group. Regression analysis revealed that cradling bias was not predicted by either intellectual or executive functioning.

The above-mentioned findings were in line with my second hypothesis, that the leftward bias would not be influenced by intellectual or executive functioning. After taking into account impairments in intellectual and executive functioning, cradling bias was still absent in ASDs. Furthermore, despite significant differences in intellectual and executive functioning between the MH and TD Control subgroups in the main study, MH children also exhibited the leftward cradling bias. These findings support my argument that cradling bias taps into a basic intuitive/intuitive process of relating, which are intact in MH children, but impaired in ASD children.

To summarize, when an individual is asked to cradle an infant with the sole intention of putting it to sleep or soothing it, a leftward cradling bias emerges. This universal leftward bias was found to be absent in ASD children. In contrast, the leftward cradling bias was present in Control children, both typically developing and mentally handicapped. These group differences were not accounted for by differences in gender, handedness, intellectual and/or executive functioning. Findings thus supported my first two hypotheses, that (1) cradling bias was absent in ASD individuals, and (2) neither intellectual nor executive functioning impacted on cradling bias.

The leftward cradling bias was absent in ASD children, which I argue reflects deficits in primitive bottom-up empathic processes. Moreover, impairments in social and emotional reciprocity in ASDs were further highlighted via observations of the quality of the interaction between child and doll (i.e., caregiver and infant) in this scenario. ASD children engaged with the doll in the same way they would engage with an inanimate object; whereas Control children, both TD and MH children, seemed to naturally assume a caregiver role. I therefore argue that the cradling bias scenario is one instance where the impairments in primitive bottom-up processes of relating in ASDs can be illustrated. It reflects the absence of the innate tendency to readily interact and form relationships with others.

Empathy and empathic behaviour in autism spectrum disorders. Deficits in *empathy* are considered a defining feature of ASDs (e.g., Baron-Cohen, 1989; Baron-Cohen et al., 1985; de Bildt et al., 2005; Gillberg, 1992; Hermans, van Wingen, Bos, Putman, & van Honk, 2009). These deficits manifest in ASD individuals' deficits in empathic behaviour; the difficulties they experience in relating to others both on a cognitive and an affective level. In other words, processes involved in relating to another by *knowing* what someone else is feeling (i.e., understanding on a cognitive level) as well as processes involved in relating to another by *feeling* what someone else is feeling are impaired.

The impairments in top-down processes in ASDs have been studied extensively, as is evidenced by the numerous cognitive theories which have dominated autism research until recently (for a review, see Rajendran & Mitchell, 2007). As a result, the deficits in top-down processes involved in relating in ASDs are relatively clear. The plethora of studies to date reveal impairments in several top-down processes in ASD individuals, such as ToM, planning, inhibitory control, self-monitoring, cognitive flexibility, and attention, to mention a few (e.g., Hill, 2004; Ozonoff & Jensen, 1999; Verté et al., 2006). However, a considerable degree of heterogeneity in top-down impairments are seen in these individuals; the various ASD profiles often demonstrate several co-existing deficits in top-down processes. For example, although many ASD individuals have impaired ToM skills, roughly 20% of these individuals do develop these skills to some extent (Happé, 1994; Rajendran & Mitchell, 2007). Furthermore, although findings indicate impaired executive functions, the level of executive functioning and the difficulties experienced vary not only across the spectrum, but also between individuals (Hill, 2004; Hill & Bird, 2006; Pellicano, Maybery, Durkin, & Maley, 2006; Pennington & Ozonoff, 1996).

At its core, however, autism is a disorder of social-emotional relatedness (e.g., Bachevelier & Loveland, 2006; Rogers et al., 1986; Scrambler et al., 2007; Wing & Gould, 1979). This implies that deficits in bottom-up processes of relating pervade all ASDs. As described by Kanner (1943), autistic individuals seem to lack the innate ability to relate to and bond with others. The natural human tendency to engage in social-emotional behaviours is impaired in these individuals. It is this intuitive bottom-up mechanism which facilitates social-emotional interactions. Research focussing on the impairments in bottom-up processes, however, is lacking. As a result, the bottom-up deficits in relating in ASDs are less clearly understood.

Both top-down and bottom-up processes are necessary for adaptive social-emotional interactions. A clear understanding of the nature of the deficits in empathy characterizing ASDs requires an understanding of both top-down and bottom-up processes of relating, as empathic behaviour is informed by the interaction of these processes.

Did Affective empathy predict cradling bias? Based on the current study's results regarding the phenomenon of cradling bias, I argue that the leftward cradling bias is facilitated by innate bottom-up processes of relating. This phenomenon taps into processes which allow us to relate to others on a visceral level. I therefore hypothesized that Affective empathy scores, which involve bottom-up processes, would predict cradling bias. Cognitive empathy scores, however, would not be associated with cradling bias, as these scores involve top-down processes of relating.

I expected to find lower Affective empathy and lower Cognitive empathy scores when comparing ASD children to their TD counterparts, as both bottom-up and top-down processes of relating are impaired in ASDs. Additionally, I expected to find that MH children would score similarly to TD children and higher than the ASD children on Affective empathy, as bottom-up processes of relating should not be impaired in MH children. Furthermore, I expected that their Cognitive empathy scores would be closer to those of the ASD group (as opposed to the TD subgroup), as it was likely that top-down processes involved in relating were impaired to some degree in the MH children.

As expected, the ASD group scored significantly lower on Affective and Cognitive empathy when compared to the Control group. Furthermore, although not significantly, the MH subgroup scored lower on Affective and Cognitive empathy than the TD subgroup, and higher on Affective and Cognitive empathy than the ASD group. Although these results reflected expected differences, large standard deviations highlighted substantial heterogeneity in both Affective empathy and Cognitive empathy scores within both the ASD and Control subgroups. Given concerns surrounding the reliability and validity of the Griffith's Empathy Measure (GEM) (to be discussed below), the hypothesis that Affective empathy predicted cradling bias was not investigated.

Although some variation is always expected, the *extent* to which scores varied was cause for concern. For example, substantial variation in Affective empathy scores was not expected in the ASD group, as ASDs are a disorder characterised by impaired bottom-up empathic processes (i.e., Affective empathy). However, large standard deviations (as can be seen in Table 9) indicated considerable variation in both Affective and Cognitive empathy scores within the ASD group/subgroups. A particularly questionable result was the variation in Affective empathy scores in the LFA subgroup; a number of LFA parents reported higher scores than many of the TD parents. Furthermore, although top-down processes are impaired to varying degrees in ASDs, the variation in Cognitive empathy scores seen within all ASD subgroups was the result of quite a substantial number of parents reporting high Cognitive empathy in these children. These findings were unforeseen, as the Griffith's Empathy Measure (GEM) is established to be a reliable and valid measure of Cognitive and Affective empathy across gender and age (Dadds et al., 2008).

It is possible, albeit unlikely, that some ASD individuals do indeed engage in empathic behaviour to the degree that was indicated by their parents. This possibility cannot be excluded. However, although outliers are expected in datasets, when looking at the ASD data in particular, no one individual's Cognitive empathy or Affective empathy scores stood out as outlier/s. A particular concern was the pattern of parents' responses which emerged when looking at the data more closely. Recall that the GEM consists of 23 statements to which the parent provides a yes or no response, on a scale from -4 (strongly disagree with the statement) to +4 (strongly agree with the statement). It appears that ASD individuals' parents were more likely to rate their child's behaviour on the extreme (i.e., -4 or +4). In contrast, Control children's parents were more likely to rate their children's behaviour somewhere on the continuum (i.e., somewhere between -4 and +4). This is reflected in the difference in variation across groups, with much larger deviations from the mean across ASD subgroups when compared to the TD Control Subgroup. An argument can therefore be made that, although the GEM might be a valid and reliable measure in a TD population, as reported by Dadds and colleagues (2008), it is not an ideal measure for the non-TD population.

For decades research concerning empathy has been "hampered by measurement issues" (Dadds et al., 2008, p. 112). This difficulty in measuring empathy was apparent in the current research. The GEM was developed in order to avoid the substantial problems associated with self-report measures of empathy in children. Despite this, findings in the current research suggested that this parent-report measure was neither reliable nor valid. It is always possible that considerable bias be introduced when parents report back on their child's behaviour; in this regard parents are not objective. As Gerdes and colleagues (2010) point out, measures such as these (i.e., self-report or parent-report) are most useful when validated. Specifically, multiple sources of assessment are crucial when measuring constructs such as empathy (Dadds et al., 2008). Incorporating teacher-reports and comparing these with parent-reports reports would perhaps have offered a more objective and accurate view of these children's empathic behaviours. Direct observation would also be invaluable.

When thinking about how to measure empathy, we need to take into consideration the way in which it is conceptualized. If we are to conceptualize empathy as behaviour, reflecting the interaction between top-down and bottom-up processes of relating, it becomes apparent that the *ability* to relate does not necessarily reflect in empathic *behaviour.* Think back to the toddler throwing a tantrum in the queue: telling the mother that her child is a brat is in need of a scolding does not mean that you cannot relate. The absence of empathic behaviour does not reflect an inability to behave empathically.

How does one then measure ability if behaviour does not necessarily reflect ability? As I argue that cradling bias comes about as a result of an unconscious mechanism, the cradling bias scenario is arguably one scenario in which deficits in empathy (i.e., impairment in primitive bottom-up processes) translate into the absence of empathic behaviour (i.e., absence of the leftward cradling bias). In this way it is perhaps a measure of the *ability* to empathize.

Pretend play and relating. Pretend play is regarded a precursor of ToM skills (Charman et al., 2000; Frith & Frith, 2003). Engaging in a pretend scenario, such as the cradling bias scenario, is therefore facilitated by processes which allow us to relate to others on a cognitive level. The fact that many ASD children can be taught how to engage in pretend play draws attention to the top-down nature of this ability. The top-down cognitive nature of pretence was further highlighted in the main study, where those ASD participants who failed tasks assessing pretend play ability were all lower-functioning (i.e., PIQ < 75). It seems that although some ASD children can learn how to pretend on a cognitive level, only children who can function at a higher level can acquire this skill.

Observations of the quality of pretence, however, allude to the involvement of bottom-up processes in the cradling bias pretend scenario. As discussed before, Control children (both TD and MH) interacted with the doll as if it were a real live infant, with outer indicators of relating. This was suggestive of pretence on a level other than purely cognitive relating, or that in addition to the high level 'as if' thinking, they also engaged in bottom-up ways of relating emotionally. In contrast, ASD children engaged with the doll in the same way they would engage with an inanimate object; they did not engage and respond to the doll as a social stimulus. Although ASD individuals might cognitively understand the concept of pretend play, as is evidenced in passing the tasks assessing pretend play, observations suggested that these children were not engaging in the pretend scenario as if the doll were a real live infant. This marked difference in the quality of pretence across the two groups draws attention to the basic impairments in relating and social reciprocity experienced by ASD individuals.

To summarize, deficits in empathy characterize ASDs. Both top-down and bottom-up processes are impaired. Although findings reflected the expected lower average Cognitive and Affective empathy scores in ASDs in comparison to their Control counterparts, the reliability and validity of the measure employed (the GEM), arguably as a result of parent-report, was problematic. As a result, my third hypothesis, that Affective empathy predicted cradling bias, could not be tested.

Concerns surrounding the reliability and validity of the GEM's findings in the current research drew attention to the difficulty researchers face when attempting to measure empathy. The importance of (1) multiple measures when measuring a construct such as empathy, and (2) adequately defining empathy was highlighted. Only by taking these two points into consideration can more accurate measures of empathy can be obtained. Importantly, I argue that the cradling bias scenario acts as a measure of the ability to empathize.

Furthermore, impairments in social and emotional reciprocity in ASDs were highlighted via observations of the quality of pretence during performance of the Cradling Bias task. Although ASD individuals might cognitively understand the concept of pretend play, as is evidenced in passing the Pretend Play task, observations were suggestive of understanding what was expected of them (i.e., to cradle a doll as if it were an infant) on a cognitive level, but not being able to engage with the doll as if it were a real live infant. In other words, they related to the doll as if it were an inanimate object, but did not relate to it as a living being. I suggest that this difference in the quality of pretence reflects the impairments in the innate tendency to readily interact and form relationships with others.

Limitations and Future Directions

Certain characteristics that are often present in ASD individuals hindered the research process. For example, resistance to novelty and a reduced capacity for social interaction are obstacles when working with these individuals. These characteristics might not be seen as limitations, but they do indeed make the research process more arduous. Resistance to novelty can be problematic, as these individuals can become very distressed when routine is changed or new people (e.g., the experimenter) are introduced. Familiarization with the researcher was one way of addressing this. As this study formed part of a broader research project, each participant was seen for up to 6 sessions, lasting 90 minutes each. If sessions were shorter, more sessions were required. As a result of numerous sessions, participants were familiarized with the researcher. Furthermore, although a reduced capacity for social interaction could not be eliminated, familiarization with the researcher did promote interaction with the researcher.

Reduced capacity for pretend play. A characteristic which had to be addressed was that ASD individuals often have a reduced capacity for pretend play. The implications of this are obvious, as the Cradling Bias task involved pretending that a doll is a real-life infant. Deficits in pretend play would therefore have undermined findings of a task which relies so heavily on the ability to engage in a pretend scenario. Controlling for this potential confound was therefore crucial (as discussed earlier). To control for this, pretend play competence, assessed by performance on the Pretend Play task, was a criterion for participation in both the pilot and the main study.

Although all pilot study participants passed tasks of pretend play, a reduced capacity for pretend play was still evident in the main study where 7 ASD participants (5 LFA and 2 PDD-NOS) were unable to successfully complete tasks assessing pretend play. Specifically, lower-functioning ASD participants struggled with these tasks; the 7 participants who failed these tasks were all lower-functioning (i.e., PIQ < 75). This resulted in a less representative sample, as is often the case in ASD research. This reduced capacity for pretend play can be viewed as limiting in this way.

Gender. Research indicates that the leftward cradling bias is evident, but less pronounced in the TD male population. This study would therefore ideally have compared cradling across the genders. However, the 4:1 male-to-female ratio in the ASD population (Ingudomnukul et al., 2007; Kogan et al., 2009), reflected considerably fewer females attending the schools I recruited participants from, made recruiting of female participants an arduous task. As a result, comparison across genders was not within the scope of this research.

To control for the possible influence of gender on cradling bias, groups were matched on this variable. In the pilot study, groups were perfectly matched on gender. In the main study, however, as a result of some participants' failure on pretend play tasks, as well as the difficulty in finding female participants, groups were not perfectly matched on gender. Further analyses revealed that gender was not a significant predictor of cradling bias.

Age and cognitive barriers. This research included ASD, MH, and TD children aged 6-16 years. Age and cognitive barriers often pose a challenge for research that includes measures of higher-order functioning such as the executive functioning task employed in this research. Assessment of executive functioning in young children, as well as in populations known have impaired executive functioning, such as MH and ASD populations, is therefore often challenging.

A number of the younger TD participants had not yet learned to read. As the EF task relies on the ability to read, not all TD participants could complete this task. Similarly, the younger MH and ASD participants could not complete this task. It was unclear in some cases whether this was a result of these participants' ages or impaired executive functioning. A substantial number of both ASD and MH participants were unable to complete the EF task, despite being older. Within these groups, the lower-functioning and non-verbal ASD children could not complete this task; only four LFA children and four MH children completed this task. This is not surprising, as the nature of these groups dictate that executive functioning (and intellectual functioning) is impaired.

Impaired intellectual and executive functioning made recruiting of lower-functioning ASD participants a challenging task. These individuals are often neglected in the research as many are unable to complete tasks dependent on a higher level of functioning. As a result, studies tend to include higher-functioning ASD individuals, such as those diagnosed with high-functioning autism and Asperger's syndrome. The cost of including lower-functioning participants in this research was that some of these participants' data had to be excluded from some analyses. Analyses were run with data of all participants who could complete the EF task. Although this decreased sample size, statistical power was sufficient. Analyses revealing that EF was not a significant predictor of cradling bias in either the pilot or the main study were therefore deemed valid.

Measuring empathy. As mentioned before, for decades research concerning empathy has been "hampered by measurement issues" (Dadds et al., 2008, p. 112). It seems that in this study, relying on parent-report as a measure of empathy was not ideal. This was reflected in the concerns surrounding the reliability and validity of the Griffith's Empathy Measure (as discussed earlier). As Dadds and colleagues (2008) point out, employing multiple measures when measuring constructs such as empathy is crucial. In this research, for example, incorporating teacher-reports and comparing these with parent-reports reports would perhaps have offered a more objective and accurate view of these children's empathic behaviours, and the inclusion of direct systematic observation would also have been invaluable. In future research, more reliable and valid measures of empathy need to be developed and employed. The importance of developing more accurate measures of empathy cannot be stressed enough, as successful intervention requires accurate measurement.

Summary and Conclusions

This research investigated the occurrence of cradling bias in ASD children. Investigating cradling bias provided a way in which to empirically investigate the nature of the *deficits in empathy* said to characterize ASDs. Findings revealed that the leftward cradling bias was absent in ASD children. This is the first human population in which the leftward bias is absent. In contrast, a clear leftward bias was present in both TD and MH children.

Furthermore, cradling bias was not influenced by intellectual or executive functioning, and also not by gender or handedness. In addition to this, a marked difference in the quality of the child-doll (i.e., caregiver-infant) interaction was observed, highlighting the very basic social-emotional difficulties experienced by individuals with ASDs.

The absence of cradling bias in ASDs draws attention to very basic difficulties in relating and social reciprocity/interaction pervading all ASDs. With regards to these individuals' *empathy deficits*, their deficits in top-down empathic processes are relatively clear, whereas their bottom-up deficits are less clearly understood. As deficits in bottom-up processes of relating pervade all ASDs, research directed at investigating deficits in more basic empathic processes is crucial, and recommended.

To conclude, further research focussed on understanding the basic bottom-up processes of relating in ASDs, as is illustrated through the absence of cradling bias in ASDs, holds much value. Instead of talking about an overarching term called empathy, which clearly resists definition, focussing on pinpointing ASD individuals' social-emotional strengths and weaknesses, both top-down and bottom-up, could prove useful for managing these deficits and improving their ability to interact with and relate to others. A more nuanced understanding of precisely what mechanisms break down has implications for treatment and management of these individuals, as more targeted intervention can be developed.

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Appendix A

DSM-IV-TR Diagnostic Criteria for Autistic Disorder

A. A total of six (or more) items from (1), (2), and (3), with at least two from (1), and one each from (2) and (3):
   1. qualitative impairment in social interaction, as manifested by at least two of the following:
      a. marked impairment in the use of multiple nonverbal behaviors such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction
      b. failure to develop peer relationships appropriate to developmental level
      c. a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest)
      d. lack of social or emotional reciprocity
   2. qualitative impairments in communication as manifested by at least one of the following:
      a. delay in, or total lack of, the development of spoken language (not accompanied by an attempt to compensate through alternative modes of communication such as gesture or mime)
      b. in individuals with adequate speech, marked impairment in the ability to initiate or sustain a conversation with others
      c. stereotyped and repetitive use of language or idiosyncratic language
      d. lack of varied, spontaneous make-believe play or social imitative play appropriate to developmental level
   3. restricted repetitive and stereotyped patterns of behavior, interests, and activities, as manifested by at least one of the following:
      a. encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus
      b. apparently inflexible adherence to specific, nonfunctional routines or rituals
      c. stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)
      d. persistent preoccupation with parts of objects

B. Delays or abnormal functioning in at least one of the following areas, with onset prior to age 3 years: (1) social interaction, (2) language as used in social communication, or (3) symbolic or imaginative play.

C. The disturbance is not better accounted for by Rett's Disorder or Childhood Disintegrative Disorder.

DSM-IV-TR Diagnostic Criteria for Asperger Disorder (i.e., Asperger's syndrome)

A. Qualitative impairment in social interaction, as manifested by at least two of the following:

   1. marked impairment in the use of multiple nonverbal behaviours such as eye-to-eye gaze, facial expression, body postures, and gestures to regulate social interaction
   2. failure to develop peer relationships appropriate to developmental level
   3. a lack of spontaneous seeking to share enjoyment, interests, or achievements with other people (e.g., by a lack of showing, bringing, or pointing out objects of interest to other people)
   4. lack of social or emotional reciprocity

B. Restricted repetitive and stereotyped patterns of behaviour, interests, and activities, as manifested by at least one of the following:

   1. encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus
   2. apparently inflexible adherence to specific, non-functional routines or rituals
   3. stereotyped and repetitive motor mannerisms (e.g., hand or finger flapping or twisting, or complex whole-body movements)
   4. persistent preoccupation with parts of objects

C. The disturbance causes clinically significant impairment in social, occupational, or other important areas of functioning.

D. There is no clinically significant general delay in language (e.g., single words used by age 2 years, communicative phrases used by age 3 years).

E. There is no clinically significant delay in cognitive development or in the development of age-appropriate self-help skills, adaptive behaviour (other than in social interaction), and curiosity about the environment in childhood.

F. Criteria are not met for another specific Pervasive Developmental Disorder or Schizophrenia.

Appendix B

DSM-IV Diagnostic Criteria for Mental Retardation

Definition

A developmental condition that is characterized by significantly lower then average level of general intellectual functioning. Failure to develop cognitive abilities and achieve an intelligence level that would be appropriate for their age group.

Mild Mental Retardation About 85% of persons that are Mental Retarded fall into this group.	IQ level 50-55 up to about 70
Moderate Mental Retardation About 10% of persons that are Mental Retarded fall into this group.	IQ level 35-40 to 50-55
Severe Mental Retardation About 3% to 4% of persons that are Mental Retarded fall into this group.	IQ level 20-25 to 35-40
Profound Mental Retardation About 1% to 2% of persons that are Mental Retarded fall into this group.	IQ level below 20 or 25

Mental Retardation Severity Unspecified: When there is a "STRONG" presumption of Mental Retardation but standard test can not be used to determine level of impairment.

Criteria

A. Intellectual functioning significantly below average. IQs of about 70 or lower in person who can take an IQ test. Clinical judgment must be use on those who can not take an IQ test.

B. Impairments or deficits for that age group in functioning in at last two of the following areas:
  1. Communication
  2. Health
  3. Leisure time
  4. Safety
  5. School
  6. Self-care
  7. Social
  8. Taking care of a home
  9. Work

C. The onset of impairment must be before the age of eighteen.

Appendix C

Study Information and Informed Consent and Assent Forms

UNIVERSITY OF CAPE TOWN
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Empathy and Social Understanding Research

Principal Researcher:
Susan Malcolm-Smith
Lecturer
Department of Psychology
University of Cape Town

Dear Parent(s)

You are invited to participate in a research study investigating various aspects of empathy in children diagnosed with autism spectrum disorders. This study focuses on how we relate to and bond with another individual.

The study will look at the differences in the presence of certain aspects of empathy between the various ASD (autism spectrum disorder) diagnoses. Approximately 150 children aged 7 to 16 years will participate in this study, some of whom will have disorders on the autism spectrum, and some of whom (the "control group") will not. We need both groups in order to distinguish what is unique to children with ASD diagnoses. **Your child is invited to take part in the study as part of the control group.**

Tasks administered will include tasks such as holding a doll and building with blocks. Spontaneous play sessions will be included among these tasks. We would like to video-tape these sessions to determine the handedness of your child, as well as how he/she responds to social cues. The tapes will only be watched by authorized researchers at UCT. These tapes will not be published or used as teaching material and your child will remain anonymous.

If you and your child agree to participate in the study, your child will be seen for approximately 90 minutes at a venue of your choice.

There are no risks to your child through participating in this research, and in fact we anticipate that children will find this quite enjoyable. However, if any child does become at all upset, she or he is welcome to withdraw at any point. We would like to emphasise that participation in this study is entirely voluntary, and will not affect your child's education.

If you would like your child to participate in the study, please complete the demographic and empathy questionnaires, as well as the consent form provided. Please answer all the questions as accurately and truthfully as possible. We understand that some of this information may be sensitive, but be assured that all information will be kept strictly confidential.

Should you have any questions or queries about the research or your participation, please do not hesitate to contact Lea-Ann Pileggi: (cell) 072 473 1006, (email) Lea-Ann.Pileggi@uct.ac.za, or Susan Malcolm-Smith: (phone) 021 650 4605, (email) Susan.Malcolm-Smith@uct.ac.za.

Thank you for your participation.

Lea-Ann Pileggi
Department of Psychology
University of Cape Town

CONSENT FORM

I hereby consent to my child's participation in this study.

Child's name: ________________________________

*Signature of parent/guardian:*___________________

Date: ____

I hereby consent to my child's being videotaped as part of this study. I understand that the videotape will be viewed only by UCT researchers, and will not be made public in any way.

*Child's name:*_________________________________

*Signature of parent/guardian:*___________________

Date: ____

Future research

If you would like to be notified of research projects in which you or your child might participate in future, please complete the details below.

Phone number: _________________________

Cell phone number: _________________________

E-mail address: _________________________

Mailing address: _________________________

____

UNIVERSITY OF CAPE TOWN

DEPARTMENT OF PSYCHOLOGY

Assent Form

Hello! We want to tell you about a research study we are doing. A research study is a way to learn more about something. We would like to find out more about how people understand how other people are feeling.

If you agree to join this study, you will be asked to do some tasks like drawing some pictures, telling me about the meaning of some words, and building with blocks.

There will be a few sessions, each about 45 minutes long. If you get tired, we can take a break at any time. You can also have a parent with you if you want.

We will also be video-taping some of the tasks you do, but we will not show anybody these videos.

You do not have to join this study. It is up to you. No one will be angry with you if you don't want to be in the study or if you join the study and change your mind later and stop.

If you sign your name below, it means that you agree to take part in this study.

______________________________	___________________________
Signature	Date

Appendix D

Original and Adapted Pretend Play Tasks

This task was modified from the original described by Kavanaugh, Eizenmand, and Harris (1997). The original task (see below) was judged to be female-gender stereotyped, as all stories required that children act out scenarios depicting interactions between a mother and infant. As the majority of children with autism are boys, stories were changed to depict gender-neutral events, which would be appealing to both male and female participants.

<u>Original task:</u>

Feeding the baby

"The baby is hungry.
Watch what the Mommy doll does.
Look. The Mommy doll is getting the baby's food."
Experimenter makes Mommy doll pick up spoon and dip in bowl.
"Show me what the Mommy doll does next."

Putting to the baby to bed

"The baby is tired.
Watch what the Mommy doll does.
Look. The Mommy doll is putting the baby into the crib."
Experimenter makes Mommy doll put baby in crib. (Leave blanket on the side of crib.)
"Show me what the Mommy doll does next."

Brushing the baby's teeth

"It‘s time to brush the baby‘s teeth.
Watch what the Mommy doll does.
Look. The Mommy doll is putting toothpaste onto the baby‘s toothbrush."
Experimenter makes Mommy doll squeeze toothpaste onto toothbrush.
"Show me what the Mommy doll does next."

Going outside

"It‘s time for baby to go outside.
Watch what the Mommy doll does.
Look. The Mommy doll is getting the baby‘s hat."
Experimenter makes Mommy doll take hat out.
"Show me what the Mommy doll does next."

<u>Adapted pretend scenarios employed in this research:</u>

Four stories are administered in random order. If the child acted as the agent (e.g., watered plant him/herself), the experimenter said, "That's right. Now show me what *Sam the doll* does." The child's response was recorded.

Watering the plants

"It's time to water the plants.
Watch what Sam does. Look. Sam is getting the watering can."
Experimenter makes doll take watering can.
"Show me what Sam does next."

Washing the car

"The car is really dirty! It's time to wash the car.
Watch what Sam does. Look. Sam is getting the wash cloth."
Experimenter makes doll take the cloth.
"Show me what Sam does next."

Brushing the dog

"It's time to brush the dog!
Watch what Sam does. Look. Sam is getting the doggy brush."
Experimenter makes doll take the brush.
"Show me what Sam does next."

Feeding the dog

"The dog is hungry! It's time to feed the dog.
Watch what Sam does. Look. Sam puts the dog food in the bowl."
Experimenter makes doll put food into the bowl.
"Show me what Sam does next."

Appendix E

Griffith's Empathy Measure

Example: If you somewhat agree with the statement, you would place a cross as indicated below.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

1. It makes my child sad to see another child who can't find anyone to play with.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

2. My child treats dogs and cats as though they have feelings like people.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

3. My child reacts badly when he/she sees people kiss and hug in public.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

4. My child feels sorry for another child who is upset.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

5. My child becomes sad when other children around him/her are sad.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

6. My child doesn't understand why other people cry out of happiness.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

7. My child gets upset when he/she sees another child being punished for being naughty.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

8. My child seems to react to the moods of people around him/her.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

9. My child gets upset when another person is acting upset.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

10. My child likes to watch other people open presents, even when he/she doesn't get one themselves.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

11. Seeing another child who is crying makes my child cry or get upset.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

12. My child gets upset when he/she sees anther child being hurt.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

13. When I get sad my child doesn't seem to notice.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

14. Seeing another child laugh makes my child laugh.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

15. Sad movies or TV shows make my child sad.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

16. My child becomes nervous when other children around him/her are nervous.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

17. It's hard for my child to understand why someone else gets upset.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

18. My child gets upset when he/she sees an animal being hurt.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

19. My child feels sad for other people who are physically disabled (e.g., in a wheelchair).

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

20. My child rarely understands why other people cry.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

21. My child would eat the last cookie in the cookie jar, even when he/she knows that someone else wants it.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

22. My child acts happy when another person is acting happy.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

23. My child can continue to feel okay even if people around are upset.

Strongly disagree — Strongly agree
-4 -3 -2 -1 0 +1 +2 +3 +4

Appendix F

Demographic Questionnaire

Participant no.: ______ Date: ______________

DEMOGRAPHIC QUESTIONNAIRE

A. Child's Information:

1. Name: ____________________
2. School: ____________________
3. Age: ______
4. Date of Birth (dd/mm/yy): __________
5. Sex (circle one): Male Female
6. Ethnicity: White Black Indian Coloured Asian
   Other If other please specify: ___________
7. Home Language: __________
8. Handedness (circle one): Left Right Ambidextrous
9. Number of siblings: __________
10. Number of **older** siblings: __________
11. How often does your child use a computer?

    Never ____ A few times a year ____ Once a month ____ Once a week ____ Every day ____

12. Has your child ever experienced a head injury? (e.g., being hit on the head with an object and losing consciousness as a result) YES NO

    If yes, please give details: ____

    ____

13. Has your child ever experienced any of the following medical conditions:

    a. Neurological problems (e.g., **epilepsy**, meningitis, cerebral palsy, encephalitis, Tourette's syndrome, brain tumour) YES NO

    If yes, please specify: ____

    b. Depression YES NO

    If yes, please specify: ____

    c. Memory problems YES NO

    If yes, please specify: ____

    d. Problems with their vision YES NO

    If yes, please specify: ____

e. Problems with their hearing YES NO

If yes, please specify:____

f. Is he/she currently taking any prescription medication? YES NO

If yes, what medication(s)? ____

11. Has your child ever been diagnosed with a social disorder such as conduct disorder or oppositional defiant disorder (ODD)?

YES NO

If yes, please specify:____

12. Has your child ever had a communication disorder? (For example: Having problems with understanding or producing speech, slow vocabulary development, difficulties recalling words or problems with producing sentences appropriate for his/her age.)

YES NO

If yes, please specify:____

13. Has your child ever been diagnosed with a pervasive developmental disorder (PDD) such as autism, Asperger's syndrome, Rett's disorder or childhood disintegrative disorder? (Tick the appropriate block).

No developmental disorder______

Autism______

Asperger's Syndrome_______

PDD – Not Otherwise Specified_______

Other (please specify):____

14. Has your child ever experienced learning difficulties such as dyslexia or attention-deficit / hyperactivity disorder (ADD/ADHD)? YES NO

If yes, please specify:____

B. Parent Information:

1. What is the total yearly income of the household in which you live? (Tick the appropriate block):

[NOTE: This should be total household income, not personal income.]

0-35000:______________36000-75000:____________76000-125000:___________ 126000-175000:___________

176000-225000:________226000-275000:__________276000-325000:__________326000-375000:____________

376000-425000:________426000-475000:__________476000-525000:__________ more than 526000:__________

2. Highest level of education reached for mother, father and/or guardian (please circle appropriate number).

	Biological mother	Biological father	Guardian
1) 0 years (No Grades / Standards) = Never went to school	1.	1.	1.
2) 1-6 years (Grades 1-6 / Sub A-Std 4) = Didn't complete primary school	2.	2.	2.
3) 7 years (Grade 7 / Std 5) = Completed primary school	3.	3.	3.
4) 8-11 years (Grades 8-11 / Stds 6-9) = Some secondary education (didn't complete high school)	4.	4.	4.
5. 12 years (Grade 12 / Std 10) = Completed high school	5.	5.	5.
6. 13+ years = Tertiary education Completed university / technikon / college	6.	6.	6.
7. Don't know	7.	7.	7.

3. Parental employment: (Please circle appropriate number)

	Biological mother	Biological father	Guardian
1. Higher executives, major professionals, owners of large businesses	1.	1.	1.
2. Business managers of medium sized businesses, lesser professions (e.g. nurses, opticians, pharmacists, social workers, teachers)	2.	2.	2.
3. Administrative personnel, managers, minor professionals, owners / proprietors of small businesses (e.g. bakery, car dealership, engraving business, plumbing business, florist, decorator, actor, reporter, travel agent)	3.	3.	3.
4. Clerical and sales, technicians, small businesses (e.g. bank teller, bookkeeper, clerk, draftsperson, timekeeper, secretary)	4.	4.	4.
5. Skilled manual – usually having had training (e.g. baker, barber, chef, electrician, fireman, machinist, mechanic, painter, welder, police, plumber, electrician)	5.	5.	5.
6. Semi-skilled (e.g. hospital aide, painter, bartender, bus	6.	6.	6.

driver, cook, garage guard, checker, waiter, machine operator)			
7. Unskilled (e.g. attendant, janitor, construction helper, unspecified labour, porter, unemployed)	7.	7.	7.
8. Homemaker	8.	8.	8.
9. Student, disabled, no occupation	9.	9.	9.

4. Material and financial resources (please circle appropriate number).

Which of the following items, in working order, does your household have?

Items	Yes	No
1. A refrigerator or freezer	1.	1.
2. A vacuum cleaner or polisher	2.	2.
3. A television	3.	3.
4. A hi-fi or music center (radio excluded)	4.	4.
5. A microwave oven	5.	5.
6. A washing machine	6.	6.
7. A video cassette recorder or dvd player	7.	7.

Which of the following do you have in your home?

Items	Yes	No
1. Running water	1.	1.
2. A domestic servant	2.	2.
3. At least one car	3.	3.
4. A flush toilet	4.	4.
5. A built-in kitchen sink	5.	5.
6. An electric stove or hotplate	6.	6.
7. A working telephone	7.	7.

Do you personally do any of the following?

Items	Yes	No
1. Shop at supermarkets	1.	1.
2. Use any financial services such as a bank account, ATM card or credit card	2.	2.
3. Have an account or credit card at a retail store	3.	3.

Appendix G

Additional Tables and Results

Table A

Demographic Characteristics of ASD and Control Subgroups in the Main Study

Characteristic	Subgroup					
	LFA (*n* = 10)	HFA (*n* = 15)	AS (*n* = 15)	PDD-NOS (*n* = 13)	MH (*n* = 15)	TD (*n* = 25)
Age range (years: months)	6:5-16:2	6:10-13:9	7:6-14:1	7:3-13:6	7:3-14:0	6:4-15:1
Age (years)						
M (*SD*)	10.63 (3.27)	9.30 (1.83)	10.66 (2.28)	10.33 (2.49)	10.05 (3.03)	11.16 (1.81)
Gender						
Male: female	1: 9	3: 12	1: 14	4: 9	4: 11	5: 20
Home language						
English: Afrikaans: other	5: 2: 3	12: 1: 2	14: 1: 0	13: 0: 0	8: 2: 5	19: 3: 3
Ethnicity						
White: black: coloured	4: 3: 3	4: 3: 8	13: 0: 2	11: 0: 2	0: 5: 10	11: 5: 9
Handedness						
Left: mixed: right	0: 3: 7	1: 2: 12	0: 5: 10	0: 3: 10	1: 3: 11	0: 2: 23

Note. LFA = low-functioning autism; HFA = high-functioning autism; AS = Asperger's syndrome; PDD-NOS = pervasive developmental disorder, not otherwise specified; MH = mentally handicapped; TD = typically developing.

Table B

Cognitive and Affective Empathy Items, as Identified by Dadds et al. (2008)

Cognitive empathy items
My child can't understand why other people get upset.
My child rarely understands why other people cry.
My child would eat the last cookie, even when they know someone else wants it.
My child react badly when they see people kiss and hug in public.
My child doesn't understand why other people cry out of happiness.
My child doesn't seem to notice when I get sad.
Affective empathy items
My child becomes sad when other children are sad.
My child gets upset seeing another child being punished for being naughty.
My child seems to react to the moods of people around them.
My child gets upset when another person is acting upset.
My child cries or gets upset when seeing another child cry.
My child gets sad when watching sad movies or TV.
My child becomes nervous when other children around them are nervous.
My child acts happy when another person is acting happy.
My child can continue to feel okay even if people around are upset.